A cross sectional examination of the associations between physical activity and school facilities among youth in the COMPASS study (Year 2)

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public."

Abstract

Objective: This study examined the prevalence of physical activity of secondary students in Ontario and Alberta, Canada. This study also examined between school variability in physical activity levels, and identified school and student level characteristics that are associated with physical activity.

Methods: This cross sectional study used the COMPASS Year 2 data. This data contained information on 79 secondary schools in Ontario and 10 in Alberta, as well as student level information on 45,298 grade 9 to 12 students who attend those schools. Multilevel modeling was used to examine associations between physical activity and school and student level characteristics. Physical activity is measured by three outcome measures: achieving 60 minutes of moderate to vigorous physical activity (MVPA) daily, achieving the Canadian Society for Exercise Physiology's (CSEP) guideline for youth physical activity (achieving 60 minutes of MVPA daily as well as achieving at least 3 days per week of vigorous physical activity and resistance training), and as a continuous measure of energy expenditure (kilocalories/kilogram/day (KKD)).

Results: The prevalence of physical activity in the Year 2 COMPASS study was, 49.3% achieving 60 minutes of MVPA and 31.0% meeting the CSEP guidelines. The mean energy expenditure (KKD) value for the entire sample was 9.6 kcal/kg/day (±7.0). Low between-school variability was identified (0.8% to 1.2%) and few school level characteristics were associated with students' physical activity. Students attending public schools, compared to private schools were more likely to achieve the MVPA recommendation and the accessibility score of schools was negatively associated with students achieving the CSEP guidelines. No school level characteristics were significant for KKD when taking into account student level factors. Student

level factors were identified as significant for all three physical activity variables. Those who were least likely to achieve all measures of physical activity were females, grade 12 students, students with $0 weekly income, students who were not current binge drinkers and those who did not eat the recommended servings of fruits and vegetables and students who did not report their height or weight resulting in a missing body mass index.

Conclusions: Insufficient amount of youth are meeting guidelines for physical activity and are therefore not receiving the health benefits associated with physical activity. The current study identified low variability between schools for physical activity, which suggests that future studies should focus on student level characteristics and potentially examine specific sub-groups. The school environment may be important to certain sub-groups or when physical activity is measured using objective measures, so future research should focus on those areas. Although the current study did not find large amounts of between school variability in physical activity, schools may still be an important place to promote physical activity.

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Chapter 1: Introduction and overview

With rising health care costs due to physical inactivity reaching a total of $6.8 billion in 2009 [Janssen, 2012], physical inactivity among youth becomes a large concern. The available evidence suggests that most youth are not physically active enough to receive all of the associated health benefits [Colley et al., 2011]. Since physical activity levels track into adulthood and levels decrease as youth age [Colley et al., 2011], secondary school is a key time to attempt to stop the decline and try to improve physical activity levels. Schools have been identified as a key setting for interventions due to their ability to reach youth and the amount of time youth spend at school [Wechsler, Devereaux, Davis & Collins, 2000]. Although various school interventions have been implemented and researched, limited research has been done on school facilities for physical activity. The facilities or the built environment of schools plays a role in the physical activity levels of elementary school children [Davison & Lawson, 2006] and there is some evidence suggesting that it also plays a role in the physical activity levels of secondary school students [Hobin et al., 2012; Fein, Plotnikoff, Wild & Spence, 2004; Nichol et al., 2009; Button et al., 2013]. A cross sectional examination of 89 secondary schools participating in the COMPASS study [Leatherdale et al., 2014] examines the association between school facilities and physical activity levels of students.

Chapter 2: Literature review

2.1 Health benefits of physical activity

Physical activity has been shown to have many health benefits for youth. These benefits include improving musculoskeletal health, cardiovascular health, blood pressure, body composition, strength and endurance, aspects of mental health, and academic performance [Strong et al., 2005]. A systematic review of the health benefits derived from physical activity was conducted to inform the Canadian Society for Exercise Physiology's (CSEP) guidelines for youth physical activity [Janssen & LeBlanc, 2010]. The systematic review demonstrated benefits from aerobic exercise specific to triglyceride levels, HDL-cholesterol levels, systolic and diastolic blood pressure, metabolic syndrome, obesity, and depression as well as benefits from resistance exercise on bone mineral density. A dose response relationship was also identified between physical activity and certain health outcomes such as obesity and metabolic syndrome [Janssen & LeBlanc, 2010]. It is not clear whether the dose response relationship is linear or curvilinear, however, it is clear that physical activity is crucial for youth health.

2.2 Canadian Society for Exercise Physiology's (CSEP) guidelines

CSEP published rigorous, evidence based, guidelines for youth physical activity in 2011, which are consistent with the World Health Organization's (WHO) guidelines [WHO, 2014a]. The CSEP guidelines were created by an advisory board which completed a comprehensive systematic review of the literature to determine the amount of physical activity that youth require to achieve health benefits [Tremblay et al., 2011]. The main recommendation of the guideline is that youth need to achieve 60 minutes of moderate to vigorous physical activity (MVPA) each day. According to the WHO moderate physical

activity (MPA) is defined as 3 - 6 metabolic equivalents (METS) and vigorous physical activity (VPA) as over 6 METS [WHO, 2014b]. One MET represents the energy expenditure of a body at rest (1 kilocalorie (kcal) per kilogram (kg) of body weight per hour = 1 MET). Examples of moderate physical activity include walking, biking, dancing, swimming and jogging. Examples of vigorous physical activity are running, competitive sports and fast swimming [WHO, 2014b]. The guidelines also outline a need for the recommended physical activity to include resistance exercises and vigorous exercise three days per week. The guidelines note that any increase in physical activity levels has health benefits, [Tremblay et al., 2011] due to the dose response relationship between physical activity and health. In summary, the guidelines recommend how much physical activity is needed to achieve health benefits using the most current evidence available [Tremblay et al., 2011].

2.3 Physical activity prevalence among youth

Although physical activity is crucial to healthy development, recommended physical activity levels are not being met in Canada. Unfortunately, according to the objectively measured Canadian Health Measures Survey (CHMS) data, less than 7% of children and youth in Canada are meeting the CSEP, moderate to vigorous physical activity (MVPA) recommendation of 60 minutes of MVPA daily [Colley et al., 2011]. Even fewer youth (<4%) are engaging in VPA 3 days a week as part of MVPA [Colley et al., 2011]. When examining self-reported physical activity of the secondary school students in Ontario, 53.1% of students were not getting 60 minutes of MVPA every day and VPA 3 days per week [Leatherdale, 2015]. Regardless of self-report or objectively measured values, rates of youth physical activity are low and are a cause for concern; it is clear that action needs to be taken to improve physical activity levels of Canadian youth.

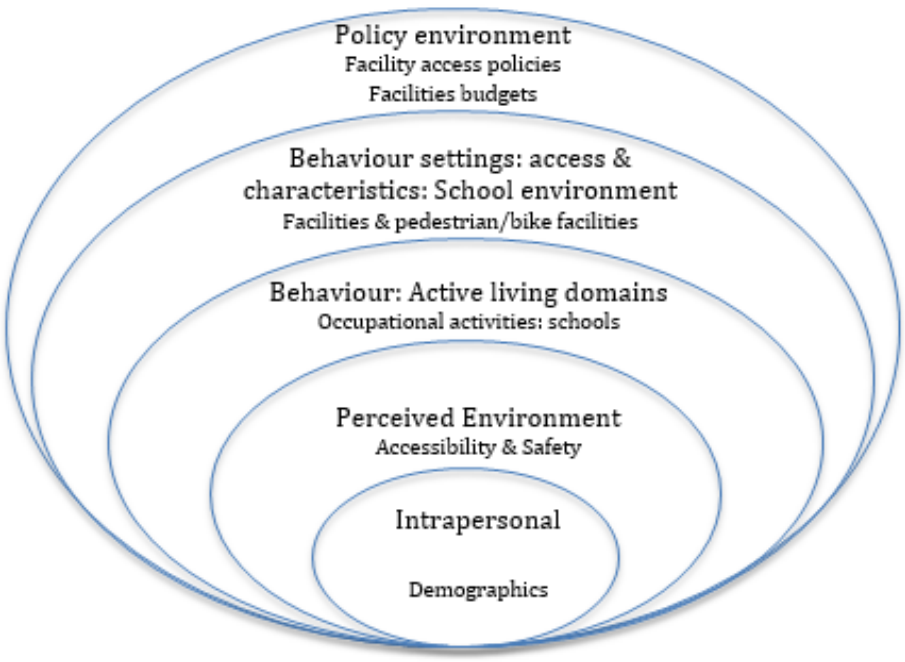
Children and youth are less likely to meet the physical activity guidelines than adults (7% vs 15% respectively) [Colley et al., 2011], which indicates that efforts to improve physical activity levels need to focus on children and youth. The focus on children and youth becomes increasingly important as they establish life-long health behaviours [Tammelin, 2004]. As children age, their levels of physical activity decline [Colley et al., 2011] and by secondary school they have already significantly decreased [Long et al, 2013]. Early interventions are important to slow the decline in physical activity levels.

2.4 Physical activity ecological models

Ecological models are commonly used in physical activity research due to the complex nature of physical activity. Sallis et al. (2006) produced an ecological model that examined creating active living communities including exercise, recreation, occupational activities and transportation. Schools are an important part of this model as it falls under the occupational domain for youth [Sallis et al., 2006]. As shown in Figure 1, this model has 5 levels: (1) policy environment, (2) behaviour settings: access & characteristics, (3) behaviour: active living domains, (4) perceived environment and (5) intrapersonal [Sallis et al., 2006]. The school facilities are mentioned directly in or are relevant to many of these levels. Within the "policy environment" the model identifies school facility access policies, and facility budgets as important. Within the "behaviour settings: access & characteristics" level, the model identifies the school environment and more specifically the school facilities and bike/pedestrian facilities. It is noted that in this domain both the access and physical facility are influential. The behaviour: active living domain called "occupational" refers to schools for youth. One of the more interior levels of the model is the "perceived environment" being accessible, convenient, safe etc. The inner most level is "intrapersonal", which includes

individual characteristics such as: demographics, biology, family and psychological. This model demonstrates the importance of the school facilities on active living or physical activity in general but also realizes the importance of individual factors and perceptions. The model emphasizes the dynamic interactions between all of the levels and the need to target individuals, social and physical environments and policies with any interventions. This ecological model is the basis for the study due to its focus on schools as a main occupational environment. Other ecological models support the notion that environmental factors, such as school facilities, play a role in physical activity [Spence & Lee, 2003; Perry, Garside, Morones & Hayman, 2012; Kremers et al., 2006], but that it represents only a piece of the larger puzzle.

Figure 1: Ecological Model of Active Living adapted from Sallis et al. 2006



Reference: Sallis, J., Cervero, R., Ascher, W., Henderson, K., Kraft, M., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Reviews Public Health, 27,* 297-322.

2.5 Occupational environment: schools

Schools have been identified as a promising site for interventions aimed at increasing child and youth physical activity levels [Wechsler et al., 2000]. Significant between-school variability in physical activity has been identified for elementary and middle school students (up to 25.9%) [Faulkner, Zeglen, Leatherdale, Manske & Stone, 2014; Leatherdale, Manske, Faulkner, Arbour & Bredin, 2010; Kristensen et al., 2013]. Whereas school level differences were found to account for 3% of the variability in student MVPA among a sample of Canadian secondary students [Hobin et al., 2012]. The variability suggests that characteristics of the school are associated with students' physical activity levels, and will be examined further in the sections below. The majority of youth, regardless of their circumstances, spend at least 6 hours per day at school and it has been shown that increasing physical activity time at school increases the total physical activity time achieved throughout the day [Long et al., 2013]. Schools are practical targets for interventions because most have facilities and space to allow for physical activity [Parrish et al., 2013].

2.6 Built environment

The built environment is described by the Public Health Agency of Canada (PHAC) as the physical surroundings that affect our health [PHAC, 2011]. The PHAC definition includes roads, parks, schools, and infrastructure that we interact with in our daily lives and supportive environments are those that can support physical activity and healthy eating [PHAC, 2011]. In schools, as outlined in the ecological model [Sallis et al., 2006] the built environment includes facilities (gyms, baseball diamonds, yoga studios, fields, bike racks, etc.), access to those facilities (are they available for each student to use during free time?) and quality of facilities (are they safe and adequate for their purpose?). The school built

environment (or school facilities) has been described in various studies as a barrier to physical activity, by youth [Dwyer et al., 2012], by teachers and by staff [Masse, Naiman & Naylor, 2013]. The built environment is a very interesting piece of the physical activity puzzle, because it can act as a passive barrier or facilitator [Dwyer et al., 2012; Masse et al., 2013] allowing for more physical activity opportunities or actually limiting what is possible.

Research has been conducted to assess the role of the built environment surrounding schools and youth physical activity. This research has mostly focused on the walkability of neighbourhoods around schools and has informed initiatives aimed at increasing active transportation, which is important because active transportation accounts for the largest proportion of daily physical activity of youth [Rainham et al., 2012]. However, the built environment surrounding schools is not within the direct control of the school and so any changes would need to come from advocacy from the school, the community and government. The built environment that the school has more power to change directly is what is on their property: the within school built environment or school facilities.

2.7 School built environment studies

The school built environment is identified as an important aspect of youth physical activity by the ecological model presented in Figure 1 [Sallis et al., 2006] and in many review papers [Wechsler et al., 2000; Parrish et al, 2013; Davison & Lawson, 2006]. When focusing on the built environment within the school, most of the research has been done on elementary and middle schools [Davison & Lawson, 2006; Van Sluijs, McMinn & Griffin 2007]. One possible reason for this focus is that elementary school students have recess, where they are encouraged to spend time outside and be active [Parrish et al., 2013]. Ontario and Alberta elementary schools have also mandated an additional 20-30 minutes of daily

physical activity to take place during instructional time [Government of Alberta, 2014, Government of Ontario, 2014].

The research has suggested that the school yard design does play a role in physical activity levels [Davison & Lawson, 2006; Van Sluijs, McMinn & Griffin 2007], and that various built environment elements (access to equipment, permanent structures, and marked courts for games) can have an effect on the intensity of exercise [Dyment, Bell & Lucas, 2009] and increase MVPA during recess by 5 min/day [Bassett et al., 2013].

To increase physical activity of children and youth, secondary school students need to be considered as well. Unfortunately there are limitations in applying elementary school research to secondary school students for a number of reasons. There is a large age difference between elementary and secondary school students, resulting in dissimilar interests, independence, maturity and barriers to physical activity [Sherar et al., 2009]. Physically, the schools take a different form as well. Most secondary schools do not have the same infrastructure for outdoor play as an elementary school or middle school does (play structures, four square, area for skipping, etc.). Therefore, it is important to examine studies done on the school built environment and physical activity specific to secondary schools. To examine studies directly relevant to the current study, which takes place within Canada, only studies conducted in Canada will be considered.

2.8 Secondary school built environment in Canada

There is limited research within Canada (6 studies were identified) that measures both the school built environment and physical activity levels of secondary school students and looks for associations between the two [Nichol et al, 2009; Button et al., 2013; Hobin et al., 2012; Hobin et al., 2012a; Hobin et al., 2013; Fein, Plotnikoff, Wild & Spence, 2004]. Six

studies are generally considered limited in this field of research especially considering the variation in methodology and results [Parrish et al., 2013].

There are two studies that use the national Canadian Health Behaviour in School Aged Children Survey as their data set and they found that having more built environment characteristics increases physical activity levels. This data set is nationally representative and uses student questionnaires to ask grade 6-10 students how many hours of MVPA the students are achieving during class and during free time at school. The data set also has administrator surveys to determine which of eight listed facilities are present at the school and their quality. Nichol, Pickett & Janssen (2009) used the 2005/2006 data to examine 154 schools, and used a dichotomous variable to examine physical activity levels (< 2 hours/week or > 2 hours/week). Nichol et al. demonstrated that among grade 9-10 students, those who attended a school with more recreational features and opportunities were more physically active during class and free time (a 1.5-1.6 fold increase in physical activity) [Nichol et al, 2009]. They did not find strong associations with any one characteristic, so they created the composite score of recreational features (and their quality) and opportunities such as varsity sports and having a policy to enhance physical activity. Button, Trites & Janssen (2013) used the Canadian Health Behaviour in School Aged Children Survey 2009/2010 data, to look at how school time physical activity is related to the number of facilities present at the school. Using data from 331 schools, they found that attending a school with the highest number of physical environment features on the school grounds was equivalent to 20 extra minutes of MVPA per week compared to students at schools with the lowest number of physical environment features. With each additional environmental feature, the students received an extra 2.4 minutes/week of MVPA at school [Button et al., 2013]. The researchers decided not

to investigate each specific facility based on the null results of the Nichol et al. (2009) study using the same dataset. The dataset itself created some limitations for the two previously mentioned studies. Although it was nationally representative, it only includes grade 6-10 students, so grade 11-12 students are not captured in the data. This is problematic when looking at secondary school students due to the fact that grade 9 and 10 students are going to have different physical activity patterns than grade 11-12 students, since physical activity decreases with grade [Leatherdale & Rynard, 2013]. Additionally, the survey for students only asked about physical activity achieved at school, so it does not allow for comparison to guidelines as it does not capture physical activity achieved outside of school. Despite these limitations, both studies provide results that demonstrate a relationship between physical activity and the school built environment.

Within Ontario, three papers were written using the School Health Action Planning and Evaluation System (SHAPES) data and identified that an alternate room for physical activity is important. Hobin et al. (2012) used SHAPES data to perform a cross-sectional study consisting of 76 secondary schools and approximately 2,000 students in grade 9-12. SHAPES provided self-reported minutes of physical activity from the last seven days, and administrator reports on how many of the fourteen listed facilities were present at the school. In the first paper the investigators identified that between-school differences accounted for 3% of the variability in student MVPA. When examining individual facilities, only one was statistically significant. They found that schools that provided an alternate room for physical activity had students with higher physical activity levels [Hobin et al., 2012]. Further examination of the original study lead to two additional papers. Hobin et al., examined the data to determine if gender changed the results, and demonstrated that school level

differences accounted for 2.1% of the variability in female physical activity levels and 2.8% of the variability in male physical activity levels, and both genders demonstrated an association with having an alternate room for physical activity [Hobin et al., 2012a]. The investigators also examined the data by stratifying by school location (urban, suburban and rural). They found that the alternate room for physical activity was only significantly associated with physical activity in urban and suburban locations and that the variability from school level differences varied by location (4.0% urban, 2.0% suburban and 2.1% rural) [Hobin et al., 2013]. These studies are not nationally or provincially representative however they capture all relevant grade levels.

The previous studies [Nichol et al, 2009; Button et al., 2013; Hobin et al., 2012; Hobin et al., 2012a; Hobin et al., 2013] have examined the presence of facilities at the schools. It has been shown that the presence and perception of built environment characteristics are important [Sallis, 2006] to student's physical activity levels. Therefore studies conducted using student's perceptions of the built environment are important to consider. An example of this is a study conducted by Fein, Plotnikoff, Wild & Spence (2004), using four secondary schools in rural Alberta. The study was cross sectional and used student self-reporting to collect physical activity levels and turn them into estimated energy expenditure, as well as collecting the perceived availability and importance of the physical environment using a modified version of an instrument developed by Sallis et al. in 1997 [Fein et al., 2004]. The results demonstrated that the perceived availability of the physical environment of their school explained 5% of the variability in energy expenditure and perceived importance explained 8% of the variability in energy expenditure. Perceived availability of physical environmental resources was important at school, home and in the

community but perceived importance was only significant at school [Fein et al., 2004]. This study suggests that perceptions are important however the low number of schools included weakens the study. The investigators did not document how many facilities actually existed at the school, they only looked at the perceptions and without further information we do not know the direction of the relationship between physical activity and the perceived built environment.

The prevention paradox [Rose, 1992] explains that a small population-level effect can be impactful by shifting the distribution of the entire population. Even a small increase in physical activity can be important due to its dose response relationship [Pate et al., 1995]. The results of the aforementioned studies all had a fairly small effect size (3-8% explained variance [Fein et al., 2004; Hobin et al., 2012], or a 1.5-1.6 fold increase [Nichol et al., 2009] or a 20 minute increase of MVPA/week [Button et al., 2013]) but it is important to note that a small effect size could have a large impact at a population level. It is also important to consider that the findings from the aforementioned studies are significant because the school built environment is within the school's control, so changes could be made that would have a positive impact on physical activity levels of the student-body. Making changes would allow schools to play a role in improving the health of their students.

Although there are so few studies published about the association between the secondary school built environment and physical activity in Canada, there is known variation in the within school built environment between secondary schools [Dwyer et al., 2006; Hobin et al., 2012]. Many studies identify the need for good facilities to be able to run programs that increase physical activity of youth [Masse et al., 2013]. School built environment research is promising since studies have already suggested an association with the recreational features

and opportunities, the number of physical environment features, an alternate room for physical activity, as well as the perceived availability and importance of the school built environment. The aforementioned studies suggest that the school built environment can make some difference in the physical activity levels of students, however due to their limited number and differing methodologies and findings more studies are warranted to explore the relationship further. Future studies should also take into account both the presence and perception of the facilities, as they are both important [Sallis, 2006]. Without access to student data on perceptions, another way to get a perception measure is to measure the access and quality of the facilities, since they would affect the student's perceptions.

2.9 Facility access policies

Policies pertaining to the accessibility of facilities is important because simply having the facilities without allowing students to access them will not increase physical activity levels. The ecological model highlights school facility access policies within its policy environment level, as well as accessibility in the perceived environment level [Sallis, 2006]. Although it is not explicitly discussed in most of the aforementioned studies, it is most likely assumed that all students have ample and equal access to facilities, however this may not be the case. Of the studies that were examined in detail, only Fein et al. (2004) addressed the access component by specifically asking students whether or not they felt that the facilities were accessible to them using the modified version of an instrument developed by Sallis et al. in 1997. Fein et al., (2004) found that availability of resources at school was positively associated with physical activity levels. Because access to facilities could change student perceptions, accessibility is an important component to examine when studying school facilities.

2.10 Quality of facilities

The quality of facilities could affect their use and student's perception of the facilities. The ecological model identifies the perceived environment as being important to physical activity, and in the model the perceived environment includes, safety, attractiveness and comfort [Sallis, 2006]; which are all considerations in quality. The only study examined previously that took into account the quality of the facilities is Nichol et al. (2009) by including the field and gymnasium quality. Nichol et al., (2009) found that for students in grade 6-10, the field condition was important to females and the gym condition was important to males when examining free time physical activity. A surveying tool for the school built environment has been developed and allows an objective measure of the quality of facilities [Leatherdale, Bredin & Blashill, 2014], so it will be possible to incorporate objective quality information in future studies.

2.11 Individual characteristics that influence physical activity

Individual characteristics are at the center of the ecological model and crucial to consider. Individual characteristics play a role in how a student will be affected by their environment. Both demographic characteristics and modifiable characteristics such as risk behaviours and outcomes are associated with individuals' physical activity levels [Leatherdale & Rynard, 2013, Terry-McElrath et al., 2011].

2.11.1 Related modifiable risk behaviours and outcomes

Low physical activity levels among youth often co-exist with other modifiable behaviours and outcomes that may contribute to chronic disease risk. Low physical activity levels have been shown to be associated with sedentary behaviour [Pearson, Braithwaite, Biddle, Sluijs & Atkin, 2014; Leatherdale & Wong, 2008], smoking [Audrain-McGovern, et

al., 2013; Terry-McElrath et al., 2011; Lisha & Sussman, 2010; deRuiter, Cairney, Leatherdale, & Faulkner, 2014; Laaksonen, Luoto, Helakorpi & Uutela, 2002; Terry-McElrath, & O'Malley, 2011], binge drinking [Terry-McElrath et al., 2011; Lisha & Sussman, 2010; Terry-McElrath, & O'Malley, 2011], overweight or obesity [Strong et al. 2005; Belcher et al., 2010; Hobin et al., 2012] and inadequate fruit and vegetable consumption [Pearson, et al., 2009; Peltzer & Pengpid, 2012; Laaksonen et al., 2002]. These risk behaviours and their co-occurrence are prevalent among youth populations [Leatherdale & Rynard, 2013]. The co-occurrence of these behaviours may place youth at an increased risk for chronic disease [Leatherdale & Rynard, 2013] as well as identify a group of students to target with interventions.

2.11.2 Demographic characteristics

Non-modifiable individual characteristics are associated with the physical activity levels of students and are important to examine in order to understand how to target interventions. It has been shown that, females achieve less physical activity than males [Leatherdale & Rynard, 2013; Belcher et al., 2010; Hobin et al., 2012; O'Loughlin, Paradis, Kishchuk, Barnett & Renaud, 1999; Iannotti & Wang, 2013] and physical activity levels decrease with grade [Leatherdale & Rynard, 2013]. A review study indicated that low socio-economic status (SES) adolescents achieve less physical activity than their higher SES counterparts [Hanson & Chen, 2007]. Studies done on Canadian children and youth looking at physical activity and ethnicity have shown that compared to other families of origin Asian [O'Loughlin et al., 1999] or East and South East Asian children and youth are the least active [Kukaswadia, Pickett & Janssen, 2014]. Although these characteristics are not modifiable, demographic characteristics are important to consider when targeting interventions.

2.12 Measuring youth physical activity

There are two main methods to consider for measuring physical activity of youth: objective and subjective measures. Objective measures such as accelerometers and pedometers tend to have more internal validity however, they are associated with issues, such as costs, feasibility and participant burden [Rachele et al., 2012]. Subjective measures such as questionnaires have less internally validity due to their self-report nature and potential for recall bias, however they have more external validity because they can be easily administered to a large group at a lower cost [Rachele et al., 2012] and do not require active consent.

Even if it were possible logistically and financially to outfit a large representative cohort of students with objective measures there would be additional challenges. Some of these challenges include ensuring participants wear the accelerometers for enough hours a day to get a comprehensive understanding of their physical activity. Many accelerometers studies use limited wear time to approximate physical activity over a longer period of time (e.g., Colley et al., 2011). Another challenge is that some activities are not captured by accelerometers or pedometers because the device will either have to be removed for the activity (e.g., swimming) or it may have trouble tracking the movement (e.g., biking). A survey is typically used to capture these activities and to determine the type of exercise done throughout the time the accelerometer is worn, in order to get the rest of the FITT principle (frequency, intensity, type and time). Even if the accelerometer is worn during an activity depending on the accelerometer or the cut offs used by the researchers the data may vary. This is due to accelerometers only tracking activity achieved at a certain threshold of intensity and maintained for a certain duration (usually determined by the researcher).

Overall, objective measures are considered to have higher internal validity than self-report measures.

However, self-report measures have higher external validity as they can more accurately capture a representative population because they do not require active consent. Self-report questionnaires are significantly more feasible for a large sample than objective measures due to lower costs and lower participant burden. There are however limitations to this method as well. When examining physical activity the FITT principle gives a complete picture and self-report can inform each metric (frequency, intensity, type and time). However many studies do not ask for all four, many ask for frequency, intensity, and time, but do not inquire about the type of activity (e.g., COMPASS), probably because of the feasibility of listing many activities. Self-report can be biased by recall, but also by response bias due to how the question is worded. Individuals' perceptions of moderate versus vigorous physical activity versus exercise may affect what people record. For example, although shoveling the driveway can be moderate physical activity people would not necessarily think of it unless prompted. There is also a lot of variability in measurement of physical activity for self-report measures.

When using a self-report questionnaire, many ways to measure and report physical activity levels exist. A common way is to ask how many minutes or hours of physical activity they have completed in the last 7 days [Hobin et al., 2012; Fein et al., 2004, COMPASS]. It is also possible to use the data in many ways. It can be compared to guidelines as dichotomous variables (such as the recommendation of 60 min/day of MVPA from the CSEP guidelines [Parrish et al., 2013, Leatherdale 2015]) or as a continuous variable such as the average daily energy expenditure (mean kilocalories per kilogram of body weight per day =

KKD). Using KKD it is possible to track one-unit changes in physical activity and the dose response relationship that exists. KKD is calculated by the equation: KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days. The equation assumes MPA is 3 METS and VPA is 6 METS (where 1 MET is the metabolic equivalent of sitting still) and is consistent with the literature [Leatherdale et al, 2008; Leatherdale, Faulkner & Arbour-Nicitopoulos, 2010; Leatherdale & Wong, 2008]. Due to the variation of measures of physical activity it may be important to examine more than one.

2.13 Host study

2.13.1 COMPASS

COMPASS (Cohort study, Obesity, Marijuana Use, Physical Activity, Alcohol Use, Smoking, Sedentary behaviour) (www.compass.uwaterloo.ca) is the first study internationally to investigate the effects of changes in policies, programs and the built environment in schools on multiple youth health behaviours and outcomes over time through quasi-experimental methods [Leatherdale et al., 2014]. COMPASS is a prospective cohort study that is funded by the Canadian Institutes of Health Research (CIHR) and collects longitudinal data (2012-2016) from a convenience sample of schools and the grade 9 -12 students attending those schools. Year 1 data includes 43 secondary schools in Ontario and Year 2 data includes 79 secondary schools in Ontario and 10 in Alberta and the 45,298 grade 9 to 12 students attending those schools [Compass, 2014]. The outcomes available in COMPASS include: tobacco, marijuana, binge drinking, intake of fruits and vegetables, obesity/overweight status, sedentary behaviours, physical activity, bullying and academic achievement. Additional details on the COMPASS host study are available in print (Leatherdale et al., 2014) or online (www.compass.uwaterloo.ca).

2.13.2 Conceptual framework for COMPASS

COMPASS uses a whole school approach that incorporates rigorous research, evaluation and knowledge exchange. COMPASS is a means of surveillance of student behaviours and outcomes as well as school policies, programs and built environment characteristics. Due to the nature of the longitudinal data, it can also evaluate programs and policies through natural experiments. Natural experiments are possible because as the schools independently implement a new policy or program, COMPASS can evaluate it with the baseline data from before the change and the data collected after the change at that school, using data from schools where no change occurred as controls. Knowledge exchange is fostered between COMPASS and schools through an annual customized knowledge exchange tool (the school health profile) and access to a knowledge broker. The knowledge broker helps to connect schools to their local resources such as public health units and aid in the knowledge transfer and exchange system. COMPASS aims to build the capacity of schools and produce practice-based evidence to improve the health of students.

2.14 Research gap

The limited available evidence suggests that the school facilities play some role in fostering or inhibiting youth physical activity. However, there is a large gap in the research. A small number of studies focusing on the secondary school built environment or facilities and physical activity of Canadian youth. The available evidence has used varied self-report questions and analyses to measure and quantify both the facilities and physical activity levels, leading to slightly different conclusions. Therefore, further research in this area is necessary to determine to what extent secondary school facilities are associated with physical activity levels among youth in Canada.

Chapter 3: Study rationale and research questions

3.1 Rationale

Physical inactivity is a serious public health concern because of its link to chronic diseases and thus the economic burden to Canadian society [Janssen, 2012]. Recommended physical activity levels are not being met by over 93% of youth in Canada [Colley et al., 2011], however schools have been identified as a convenient location to intervene. Secondary schools are ideal because the teenage years are when physical activity behaviours tend to be established [Tammelin, 2005] and youth spend many of their waking hours at school [Wechsler et al., 2000]. The ecological model created by Sallis et al. in 2006 points to school facilities playing a role in students' physical activity levels. However, there is minimal research within Canadian secondary schools on facilities and physical activity.

The COMPASS study data [Leatherdale et al., 2014] allows for between school comparisons allowing for a more thorough examination of facilities since there is known variation in the school built environment and physical activity levels [Dwyer et al., 2006; Hobin et al., 2012]. The Year 2 (2013/2014) data from COMPASS were chosen for this study because more schools were recruited in the second year (Year 1: 43 vs. Year 2: 89). Year 2 data includes 45,298 students from 89 schools in both Alberta and Ontario, Canada. The larger sample size and inclusion of a second province in Year 2 data increases the power of the study as well as the generalizability of the results.

By examining physical activity in three ways it is possible to make different comments on physical activity levels of youth. The 60 min/day of MVPA recommendation looks at students who achieve sufficient physical activity daily, the entire CSEP guideline looks at students who achieve sufficient physical activity daily but are also supplementing

throughout the week to get vigorous and resistance exercise as well, and finally KKD demonstrates the actual "dose" of physical activity that is achieved. The study will be able to expand school facility research by using observational facility data which includes a quality measure. The study is well positioned to contribute to the existing knowledge gap concerning facilities in Canadian secondary schools in and physical activity.

3.2 Research questions

Research Question 1a: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what prevalence of students achieve at least 60 min/day of MVPA every day?

Research Question 1b: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what prevalence of students meet the CSEP guidelines for youth physical activity (≥60 min/day of MVPA 7x/week, resistance exercise ≥3x/week and VPA ≥3x/week)?

Research Question 1c: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what is the mean kilocalories per kilogram of body weight per day (KKD)?

Research Question 2a: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, is there significant between-school variability in the likelihood of a student achieving at least 60 min/day of MVPA every day?

Research Question 2b: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, is there significant between-school variability in the likelihood of a student meeting the CSEP guideline for youth physical activity (≥60 min/day of MVPA 7x/week, resistance exercise ≥3x/week and VPA ≥3x/week)?

Research Question 2c: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, is there significant between-school variability in KKD?

Research Question 3a: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what school built environment characteristics are associated with the likelihood of a student achieving at least 60 min/day of MVPA every day?

Research Question 3b: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what school built environment characteristics are associated with the likelihood of a student meeting the CSEP guideline for youth physical activity (≥60 min/day of MVPA 7x/week, resistance exercise ≥3x/week and VPA ≥3x/week)?

Research Question 3c: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what school built environment characteristics are associated with higher KKD?

Research Question 4a: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what student level characteristics are associated with the likelihood of a student achieving at least 60 min/day of MVPA every day, controlling for school level characteristics?

Research Question 4b: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what student level characteristics are associated with the likelihood of a student meeting the CSEP guideline for youth physical activity (≥60 min/day of MVPA 7x/week, resistance exercise ≥3x/week and VPA ≥3x/week), controlling for school level characteristics?

Research Question 4c: Among grade 9-12 students attending the 89 secondary schools in Year 2 of COMPASS, what student level characteristics are associated with higher KKD, controlling for school level characteristics?

3.3 Hypotheses

Research Question 1a: I expect that the majority of COMPASS youth will not meet this recommendation, supported by research showing that when examining self-reported physical activity of the secondary school students in Ontario, 53.1% of students were not getting 60 minutes of MVPA every day and VPA 3 days per week [Leatherdale, 2015]. It is expected that a similar amount of students will meet 60 minutes of MVPA for 7 days/week.

Research Question 1b: I expect that less than 50% of students will meet the CSEP guidelines for youth physical activity. This is hypothesized based on previous reports documenting that 53.1% of secondary school students were not getting 60 minutes of MVPA every day and VPA 3 days per week [Leatherdale, 2015]. It is hypothesized that an even lower percentage of students will be performing resistance exercises three times a week as well.

Research Question 1c: I expect that the mean KKD will be >3 KKD. The Canadian Community Health Survey reported about 75% of youth in Ontario and Alberta had >1.5 KKD [Statistics Canada, 2012]. However, taken with data that about 50% of youth achieved the 60 minutes of MVPA/day (>3 KKD), I would expect the average to be over 3 KKD.

Research Question 2a&b: I expect significant between-school variability in students achieving the CSEP guidelines and the 60 minute/day MVPA recommendation [Hobin et al., 2012].

Research Question 2c: I expect significant between-school variability in the mean KKD

[Hobin et al., 2012].

Research Question 3a&b: Based on previous research, I expect the total physical activity resource number [Nichol et al., 2009; Hobin et al., 2012; Button et al., 2013] to be a significant correlate, as well as the accessibility and quality of facilities [Fein et al., 2004]. There is anticipated variance in the presence and strength of association depending on the built environment characteristic, as demonstrated in previous studies [Nichol et al., 2009; Hobin et al., 2012; Button et al., 2013].

Research Question 3c: Based on previous research, I expect the total physical activity resource number [Nichol et al., 2009; Hobin et al., 2012; Button et al., 2013] to be a significant correlate of KKD, as well as the accessibility and quality of facilities [Fein et al., 2004]. There is anticipated variance in the presence and strength of association depending on the built environment characteristic, as demonstrated in previous studies [Nichol et al., 2009; Hobin et al., 2012; Button et al., 2013].

Research Question 4a&b: Based on previous literature, I expect males be more likely than females to achieve the CSEP and MVPA guideline and as grade increases, the odds of achieving CSEP or MVPA guidelines will decrease [Leatherdale & Rynard, 2013]. I also expect that certain modifiable behaviours will be associated with achieving CSEP and MVPA guidelines. I expect that current smokers, binge drinkers and marijuana users will be less likely to achieving the guidelines than non-users [Audrain-McGovern et al., 2013; Terry-McElrath et al. 2011], that sedentary [Pearson et al., 2014] and overweight or obese youth will be less likely to meet the guidelines [Strong et al. 2005, Belcher et al., 2010].

Research Question 4c: Based on previous literature, I expect males will have higher KKD than females and that KKD will decrease with grade [Leatherdale & Rynard, 2013]. I also

expect that certain modifiable behaviours will be associated with KKD. I expect that current smokers, binge drinkers and marijuana users are less likely to have higher KKD than non-users [Audrain-McGovern et al., 2013; Terry-McElrath et al. 2011], that sedentary [Pearson et al., 2014] and overweight or obese youth are less likely to have high KKD values [Strong et al. 2005, Belcher et al., 2010].

Chapter 4: Methodology

4.1 Study design

The study consists of a cross-sectional secondary analysis of data collected through the COMPASS study, data Year 2 (2013/2014). Data from the convenience sample of 89 secondary schools and the 45, 298 grade 9 to 12 students attending those schools in Ontario and Alberta, Canada [Compass, 2014] included in COMPASS is used. A cross sectional design was chosen based on the data available. It was not realistic to use COMPASS as a longitudinal study at the current stage because it only has two data points and it is unlikely that many of the Year 1 schools would have drastically changed their facilities and policies within the first year. The cross-sectional analysis can be used as a baseline for future longitudinal studies done with COMPASS data and may give some indication of what to focus on moving forward.

4.2 COMPASS methods

4.2.1 School sampling

Schools are sampled based on a convenience sample of the school boards. The school board had to agree to allow schools to use active information-passive consent parental permission protocols (all parents are actively made aware of the study but if they do not withdraw their child it is assumed that they have given consent). This sampling procedure resulted in a convenience sample of 79 school in Ontario and 10 in Alberta for the Year 2 data.

4.2.2 School recruitment

Once the school board had given permission for active information- passive consent and agreed to allow their schools to participate in the study, all eligible schools were approached and asked if they wanted to participate [Compass, 2013]. The inclusion criteria were use of active information-passive consent and having over 100 students in each grade level at the school. 43 schools in Ontario were recruited for the Year 1 data. In Year 2, 36 more schools in Ontario and 10 schools in Alberta joined the 43 original schools to create a sample of 89 schools.

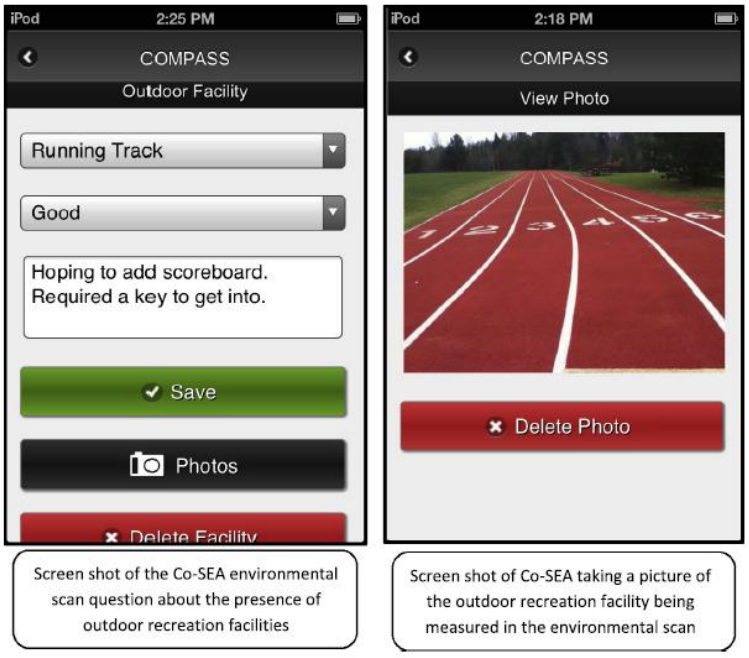
4.2.3 School level data collection

COMPASS uses an administrator survey to annually collect data on the program and policy environment of the school and an application on a smart phone is used to objectively collect information on the school built environment characteristics.

To examine the within school built environment a smart phone application (COMPASS school environment application (Co-SEA)) was created [Leatherdale, Bredin &Blashill, 2014]. A picture is taken of each characteristic by the trained COMPASS data collector and they are rated on their quality [Leatherdale, Bredin &Blashill, 2014], as seen in Figure 2. The application contains a list of facilities (gymnasium, fitness room, running track etc.) to choose from and the data collector is then prompted to take a picture of the facility. Each data collector is trained as to what needs to be visible in each picture to ensure consistency. In addition to the picture, the data collector is prompted to rate the quality of the facility with the option to click “good”, “adequate”, “poor”, or “unable to access”. Each data collector has been given the same verbal training as to what constitutes a good versus adequate track and a good gym compared to a poor gym, for example (Appendix A). A space

is also available in the application to add notes. Additionally, if there is a facility or element of the built environment that is not listed, it can be added manually based on their training. The application is adapted from other validated built environment measures examining food and physical activity environments, (SPEEDY [Jones et al., 2010] and ENDORSE [Van der Horst et al., 2008]) however the Co-SEA application has not been validated for inter-rater reliability.

Figure 2: Co-SEA screen shot of a track



Reference: Leatherdale, S., Bredin, C., & Blashill, J. (2014). A software application for use in handheld devices to collect school built environment data. *Measurement, 50,* 331-338.

4.2.4 Student recruitment

Consent for student participation at each school was achieved using active information-passive consent. Letters explaining the research were mailed to parents. If parents had questions or wanted to withdraw their child from the study they were asked to contact the researchers at the provided toll free number or email address. Students could also

choose to withdraw at any time. This recruitment method received ethics approval from the University of Waterloo, Office of Research Ethics. For the Year 2 data 57,283 students were enrolled in the participating schools and of them 45,298 students participated (response rate of 79%, with only 0.01% refusal, other missing respondents were due to absenteeism on the day of the survey).

4.2.5 Student level data collection

COMPASS annually collects individual student data on physical activity, height and weight, sedentary behaviour, smoking, alcohol and marijuana use, fruit and vegetable consumption, etc., using scientifically supported self-report measures. Demographic characteristics are also collected such as gender, age, grade, race, and a proxy measure for SES. Many aspects of the student questionnaire have been validated and shown to be adequately reliable for use with large samples of youth. These include tobacco use, fruit and vegetable consumption, overweight and obesity, sedentary behaviour and physical activity [Wong et al., 2012; Leatherdale & Laxer, 2013; Leatherdale, Laxer & Faulkner, 2014]. Self-report measures are used in COMPASS due to the large sample size and because objective measures necessitate active consent.

4.2.5.1 COMPASS physical activity questions

The questions used to examine physical activity (Appendix B) have been validated for use with a large sample size and with youth specifically [Leatherdale, Laxer & Faulkner, 2014]. A reliability study was done on the physical activity questions with a 1 week retest. The results of the reliability study showed moderate intraclass correlation coefficient (ICC) values (0.68-0.75). These values were deemed acceptable because some day-to-day variation is expected in physical activity levels and they were consistent with previous literature

[Leatherdale, Laxer & Faulkner, 2014]. To test the validity, accelerometer data was used. As reported by Leatherdale et al., the ICC values (0.18-0.25) were considered slight, however the values were on par with other self-report measures of physical activity and so the COMPASS survey is deemed to be an acceptable measure of youth physical activity levels [Leatherdale, Laxer & Faulkner, 2014]. It was found that youth tended to overestimate their MVPA levels on the self-report measure compared to what was collected by accelerometers, however it is interesting to note that youth overestimated VPA but underestimated MPA which still lead to an overestimation of MVPA but the estimation is much closer when taken together as MVPA [Leatherdale, Laxer & Faulkner, 2014]. As a result, MVPA was considered in most measures.

4.3 Measures

Based on the COMPASS dataset, relevant variables were chosen to answer the research questions. The COMPASS student questionnaire is found in Appendix B. For school level characteristics data from the first year that schools participated in the study will be used in order to keep the data consistent as the second year a school participates they receive a different questionnaire for school policies. The COMPASS data will be analyzed for physical activity using the CSEP guideline and MVPA recommendation as cut points in order to compare the results to common guidelines. Additionally, KKD will be used to examine the data as a continuous variable. Facility variables will be created in order to examine the presence, access and quality of facilities for physical activity at the school. Other variables will also be created to control for school and student level factors.

4.3.1 Student level physical activity measures

Moderate/vigorous physical activity (MVPA) was operationalized using a combination of two survey questions: "Mark how many minutes of HARD physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time" and "Mark how many minutes of MODERATE physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities." The definitions of HARD and MODERATE are given as: "HARD physical activities include jogging, team sports, fast dancing, jump-rope, and any other physical activities that increase your heart rate and make you breathe hard and sweat." and "MODERATE physical activities include lower intensity activities such as walking, biking to school, and recreational swimming." The *MVPA* physical activity variable allows for comparison to the CSEP guidelines [CSEP, 2014]. Combining MPA and VPA also allows for a more valid self-report measure for physical activity from students [Leatherdale, Laxer & Faulkner, 2014]. This variable was treated as a dichotomous variable stating whether students are meeting 60 minutes per day or not (Yes=1 /No=0).

Resistance exercise / training (RT) is a dichotomous variable (Yes=1 /No=0) determining if the student has met the CSEP guidelines of at least 3 days per week of resistance exercise. This was measured by a self-report question on the student survey: "On how many days in the last 7 days did you do exercises to strengthen or tone your muscles? *(e.g., push-ups, sit-ups, or weight-training)"*.

Vigorous physical activity (VPA) was operationalized as the number of days in a week that students report "HARD" activity. This is a dichotomous variable (Yes =1 /No= 0) to indicate whether the participants met the CSEP guidelines of at least 3 days per week of vigorous activity.

A variable called *CSEP* was created to indicate whether students are succeeding in meeting the entire CSEP guidelines [CSEP, 2014]. This variable used the following three dichotomous variables (MVPA, VPA, and RT). The CSEP variable is also dichotomous (Yes =1/No =0). If all 3 previous variables were "1" then this variable was a "1", but if any of them were "0" then this variable was also "0".

KKD (kilocalories per kilogram of body weight per day) incorporated the answers from the two questions: "Mark how many minutes of HARD physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time" and "Mark how many minutes of MODERATE physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities." The answers were turned into hours and plugged into the equation (KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days) to allow for a continuous physical activity variable. This is consistent with research by Leatherdale, Faulkner & Arbour-Nicitopoulos (2010), Leatherdale & Wong (2008) and Leatherdale et al. (2008). Students who reported physical activity levels resulting in a value of 0 for KKD will be included because they provided data suggesting low physical activity levels.

4.3.2 School facility measures

Facilities were collected using the Co-SEA application [Leatherdale et al., 2014]. The options presented to data collectors in Co-SEA for "physical activity observations" include: "Indoor facilities": Gymnasium or other large room, Fitness room, Swimming pool, Skating rink/arena, Other indoor ; "Outdoor facilities": Running track, Soccer/football/rugby pitch, Basketball courts, Tennis courts, Other paved area used for activity, Bicycle racks, Other outdoor. Co-SEA created a list of facilities that are present at each school and how many of each there are. The list was considered as three variables*: total number of facilities, number of indoor facilities and number of outdoor facilities*. These variables were selected because Nichol et al., 2009 found that no specific facility was significant but the cumulative number of facilities was. Other studies have also used the total number of facilities [Hobin et al, 2012; Button et al., 2013].

Facility quality was based on the ratings given to the facilities by the COMPASS data collectors using Co-SEA. The collectors rate each facility as "Good", "Adequate", "Poor", or "Unable to access". These adjectives were given a numerical value from 1-3 (Good=3, Adequate=2, Poor=1), and an average condition score was created using all of the rated facilities. Facilities rated as "unable to access" were not considered in the average condition score. This measure was created to expand on a study by Nichol et al. (2009) which explored the quality of fields and gymnasiums.

Facility access during non-instructional time was based on three questions in the administrator questionnaire regarding whether the majority of students have access to facilities during free time. "Do the majority of students at your school have regular access to indoor physical activity areas *during non-instructional school time? (e.g., during lunch,*

spare periods); Do the majority of students at your school have regular access to outdoor physical activity areas *during non-instructional time? (e.g., during lunch, spare periods);* Do students have access to various physical activity equipment such as, soccer and basketballs *during non-instructional times* throughout the school day *(e.g., during lunch, or spare periods)?"* Each question was coded as (Yes=1/No=0). These questions were also taken together, by adding the responses (0 (all no) – 3 (all yes)).

To examine other aspects of accessibility a second measure was used to determine an *accessibility score*. The three questions used above were added to the questions, "Outside of school hours, does your school permit regular student access to the following? Gymnasium(s), Indoor facilities (e.g., dance studio, yoga room, fitness room), Outdoor facilities (e.g., playing fields, paved activity areas, baseball diamond), Equipment (e.g., soccer balls, basketballs)" and *"*Do the majority of students at your school have regular access to any of the following*?* Secure change room lockers available for use during physical activity, change rooms available for use before and after physical activity, privacy curtains/stalls not including shower or bathroom stalls available for Girls? Boys?, Clean showers available for use before and after physical activity for Girls? Boys?." With each option in the lists counting as a question, there is a total of 13 possible Yes answers. To achieve this accessibility score, only "yes" answers were considered therefore "no" and a lack of response would count as a 0, unless responses were missing for all 13 questions.

4.3.3 School level descriptive measures

School enrolment was used to give an idea of school size. Schools with 500 students and under were classified as small, schools with 501 to 1,000 students were classified as medium and schools with over 1,001 students were classified as large.

School location used the 2011 census definitions to determine the classification [Statistics Canada, 2012]. “Large Urban” is described as populations from 100,000 and greater and a population density of at least 400 per square kilometre, “Medium Urban” is populations between 30,000 to 99,999 and a population density of at least 400 per square kilometre, “Small Urban” is populations between 1,000 to 29,000 and a population density of at least 400 per square kilometre, and finally “Rural” represents population less than 1,000 or population density less than 400 per square kilometre.

A *school type* variable was used to compare private and public schools. Public schools are schools funded by the government (Public school board and Catholic school board) and private schools are those with independent funding.

4.3.4 Student level measures

COMPASS collects demographic characteristics of students as well as information on their modifiable behavioural characteristics. Coding of the modifiable characteristics is consistent with studies done by Leatherdale & Rynard (2013) and Leatherdale (2015).

Demographic characteristics:

Grade: Respondents were asked “What grade are you in?” Response options are a list of the grades. Students who selected “Grade 9” were coded as 0 and acted as the reference group in the models, “Grade 10” are coded as 1, “Grade 11” are coded as 2 and finally “Grade 12” are coded as 3. Due to the high correlation with age and the relevance to schools, only grade was considered.

Gender: Respondents were asked “Are you female or male?” Students who selected female were coded as 0 and acted as the reference group and those who selected male were coded as 1.

Ethnicity: Respondents were asked "How would you describe yourself? *(Mark all that apply)"* The response options were as follows: White, Black, Asian, Aboriginal (First Nations, Métis, Inuit), Latin American/Hispanic, Other. Consistent with Leatherdale et al. (2010), students who responded "White" only were coded as 0 and acted as the reference group and all other responses were coded as 1. Students who identified as "White" as well as another option are also coded as 1.

Weekly spending money: Respondents were asked "About how much money do you usually get each week to spend on yourself or to save? *(Remember to include all money from allowances and jobs like baby-sitting, delivering papers, etc.)"* This question was used as a proxy measure for SES. The response options were as follows: Zero, $1 to $5, $6 to $10, $11 to $20, $21 to $40, $41 to $100, More than $100, I do not know how much money I get each week. The response options have been collapsed into fewer categories to stay consistent with numerous other studies [Cole, Leatherdale & Burkhalter, 2013; Elton-Marshall, Leatherdale & Burkhalter, 2012; Leatherdale & Burkhalter, 2012]. The coding was as follows: Zero (0 = reference group), $1 to $20 (1), $21 to $100 (2), More than $100 (3), I do not know how much money I get each week (missing).

Modifiable characteristics:

Binge drinking: Respondents were asked "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?" with response options: I have never done this, I did not have 5 or more drinks on one occasion in the last 12 months, Less than once a month, Once a month, 2 to 3 times a month, Once a week, 2 to 5 times a week, Daily or almost daily.

Consistent with Leatherdale & Rynard (2013) and Leatherdale (2015) students were classified as a current binge drinker if they reported this behaviour once a month or more

frequently. Current binge drinkers were coded as 1 and compared to the reference group of those who are not current binge drinkers (coded as 0).

Marijuana Use: Respondents were asked "In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)" with response options: I have never used marijuana, I have used marijuana but not in the last 12 months, Less than once a month, Once a month, 2 or 3 times a month, Once a week, 2 or 3 times a week, 4 to 6 times a week, Every day.

Consistent with Leatherdale & Rynard (2013) and Leatherdale (2015) students who reported using marijuana once a month or more frequently were considered current marijuana users and were coded as a 1. The reference group (0) was students who have never used marijuana or do so less than once a month.

Tobacco Use: Respondents were asked "Have you ever smoked 100 or more whole cigarettes in your life?" with response options: Yes and No. Respondents were also asked "On how many of the last 30 days did you smoke one or more cigarettes?" with response options: None, 1 day, 2 to 3 days, 4 to 5 days, 6 to 10 days, 11 to 20 days, 21 to 29 days, 30 days *(every day*).

Consistent with Leatherdale & Rynard (2013) and Leatherdale (2015) students were classified as current smokers and coded as a 1 if they had ever smoked 100 cigarettes and smoked one or more cigarettes in the last 30 days. The reference group (0) was every other student that responded.

Fruit and vegetable consumption: Respondents were asked "YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of vegetables and fruits did you have? *One 'Food Guide' serving of vegetables and fruit includes pieces of fresh*

vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice" with response options: None, 1 serving, 2 servings, 3 servings, 4 servings, 5 servings, 6 servings, 7 servings, 8 servings, 9 or more servings.

Consistent with Leatherdale & Rynard (2013) and Leatherdale (2015) males who reported less than 8 servings per day and females who reported less than 7 servings per day were coded as 1, and compared to the reference group who met the recommended fruit and vegetable servings for their gender. These cut offs are also consistent with the Canadian Food Guide recommendations for youth [Health Canada, 2014].

Overweight and obesity: Respondents were asked "How tall are you without your shoes on? (Please write your height in feet and inches OR in centimeters, and then fill in the appropriate numbers for your height.)" and "How much do you weigh without your shoes on? (Please write your weight in pounds OR in kilograms, and then fill in the appropriate numbers for your weight.)" There was a response option of "I don't know" as well as a place to record the appropriate number.

Using the self-reported height and weight measures, body mass index (BMI) was calculated using the equation: kg/m^2. The World Health Organization cut offs were used to classify BMIs as normal, underweight, overweight or obese. Students classified as underweight were coded as 0, normal weight as 1 (and act as the reference group in the models), overweight as 2, obese as 3 and students with missing height and/or weight were coded as 4 and kept in the analysis.

Sedentary behaviour: Respondents were asked "How much time per day do you *usually* spend doing the following activities?" a) Watching/streaming TV shows or movies b)

Playing video/computer games c) Doing homework d) Talking on the phone e) Surfing the internet f) Texting, messaging, emailing (note: 50 texts = 30 minutes) g) Sleeping. The response options available represented: Hours: 0-9 and Minutes: 0, 15, 30, 45.

Consistent with Leatherdale (2015) the times were added together for each activity except for sleeping and homework and if the student was sedentary for 2 or more hours per day they were considered "sedentary" and coded as 1. This cut off is also consistent with the Canadian Sedentary Behaviour Guidelines for youth, which recommends less than 2 hours/day of sedentary behaviour [CSEP, 2014].

4.4 Data analysis

All analyses were performed using the statistical package SAS version 9.4. To answer some of the research questions, a multilevel logistic or multilevel linear regression analysis was necessary due to the hierarchical nature of the data. There are many advantages to multilevel analyses including allowing for examination of how covariates at multiple levels affect the outcome variable and interact with other covariates [Guo & Zhao, 2000]. Due to the clustered nature of the data it was necessary to do multilevel analyses because the school and student level data were not independent of each other (they are nested), and need to be considered together. By considering the nested data as such, it allows for less bias in the parameter estimates and more correct standard error estimates, confidence intervals and significance tests [Guo & Zhao, 2000]. The multilevel model also estimates how much variance is attributable to each level [Guo & Zhao, 2000]. For all of these reasons, it is important to use multilevel regression analysis for the nested data.

To answer research question 1, descriptive statistics such as frequency counts, chi squares or t-tests analyses were used to determine if there were significant differences.

Three steps were necessary to answer the remaining research questions (one for each question). For research questions 2a&b-4a&b the following steps use logistic modeling and for research questions 2c-4c the following steps use linear modeling due to the nature of the dependent variable.

Step 1 (research question 2) considered the between school variability. To determine if there was significant variability, ICCs (intraclass correlation coefficient) were calculated (equation shown below). The responses are more similar if the ICC value is large. In the context of the study a value closer to 1 means that school level variability is important because the students at a school are similar. However, if the ICC value is 0, this would signify that the responses in a school are not similar and so the variation is not due to school level characteristics but instead due to student level characteristics. Therefore, if the ICC values are above 0 then this would suggest that there are some between school differences and a model would be created including all of the school level characteristics for step 2. If the ICC values are 0, then step 2 will be skipped, since nothing will be significant.

ICC = $\rho = \sigma_u^2/(\sigma_u^2 + \sigma_e^2)$ where σ^2_u = variance in level 2 random effect

σ^2_e = variance in level 1 random effect

Dichotomous measures =$3.14^2/3$

In step 2 (research question 3) all of the school level characteristics (number of total facilities, number of indoor facilities, number of outdoor facilities, average condition of facilities, accessibility score, facility access during non-instructional time, school enrolment, school locations and school type) were examined. Each variable was added to the model individually to determine significance. The school level characteristics were deemed

significant if they achieve a p-value of less than 0.05. Following the univariate analysis, a multivariate analysis was performed with all significant school level variables.

If there were significant school level characteristics then all of the student level characteristics are added to that multilevel model for step 3 (to answer research question 4). However, if there were no significant school level characteristics then a simpler logistic or linear regression analysis would be done on only the student level characteristics, because there is no effect of nesting. In either case a p-value of 0.05 was used to determine significance in the final model.

Model fit is important to determine if the model is in fact properly representing the data. When using GLIMMIX procedure in SAS for multilevel models it is not required to fit each model at each stage [Witte et al., 2000].

Multicolinearity is when predictive variables are correlated and is an issue that will inevitably be present within the COMPASS data set. Due to the nature of the data being a real world situation where more than one factor affects the outcome, it is advisable to simply interpret the results knowing that multicolinearity exists. However, some steps were taken to diminish its effects, such as only considering grade instead of both age and grade since they would yield similar results.

The original sample in COMPASS Year 2 data included 45,298 students, however students were excluded if any variable examined was missing except for BMI. Missing data was kept for BMI, because there were 6,690 students who did not report their height and/or weight. The missing data was considered independently to determine if it was significant. The final sample used for this analysis was 35,297 students

4.6 Ethics

The COMPASS study received ethics approval from the University of Waterloo, Office of Research Ethics. The ethics approval has been extended for the use of the data within the current study. Ethics was received on March 31, 2014.

Chapter 5: Results

5.1 Descriptive results for student level characteristics

Of the 35,297 students from 89 secondary schools included, 49.9% self-identified as male and 25.3% self-identified as being in grade 9, 26.0% in grade 10, 25.1% in grade 11 and 23.6% in grade 12. Overall, 49.3% (n=17,407) achieved 60 minutes of MVPA daily and 31.0% (n=10,947) of the sample met the CSEP guidelines. The mean KKD value for the entire sample is 9.6 kcal/kg/day (±7.0), ranging from 0 to 42.8 kcal/kg/day.

5.1.1 Descriptive results for students by gender

As shown in Table 1, females were more likely than males to have identified as "white only" ($p<.001$), and more likely to have reported $1-99 of weekly spending money ($p<.001$). Females were less likely than males to report being substance users, including being current binge drinkers, current marijuana users, or current smokers ($p<.001$). Females were more likely than males to report eating recommended servings of fruit and vegetables ($p<.001$), not being sedentary ($p<.001$) and being classified as normal weight ($p<.001$).

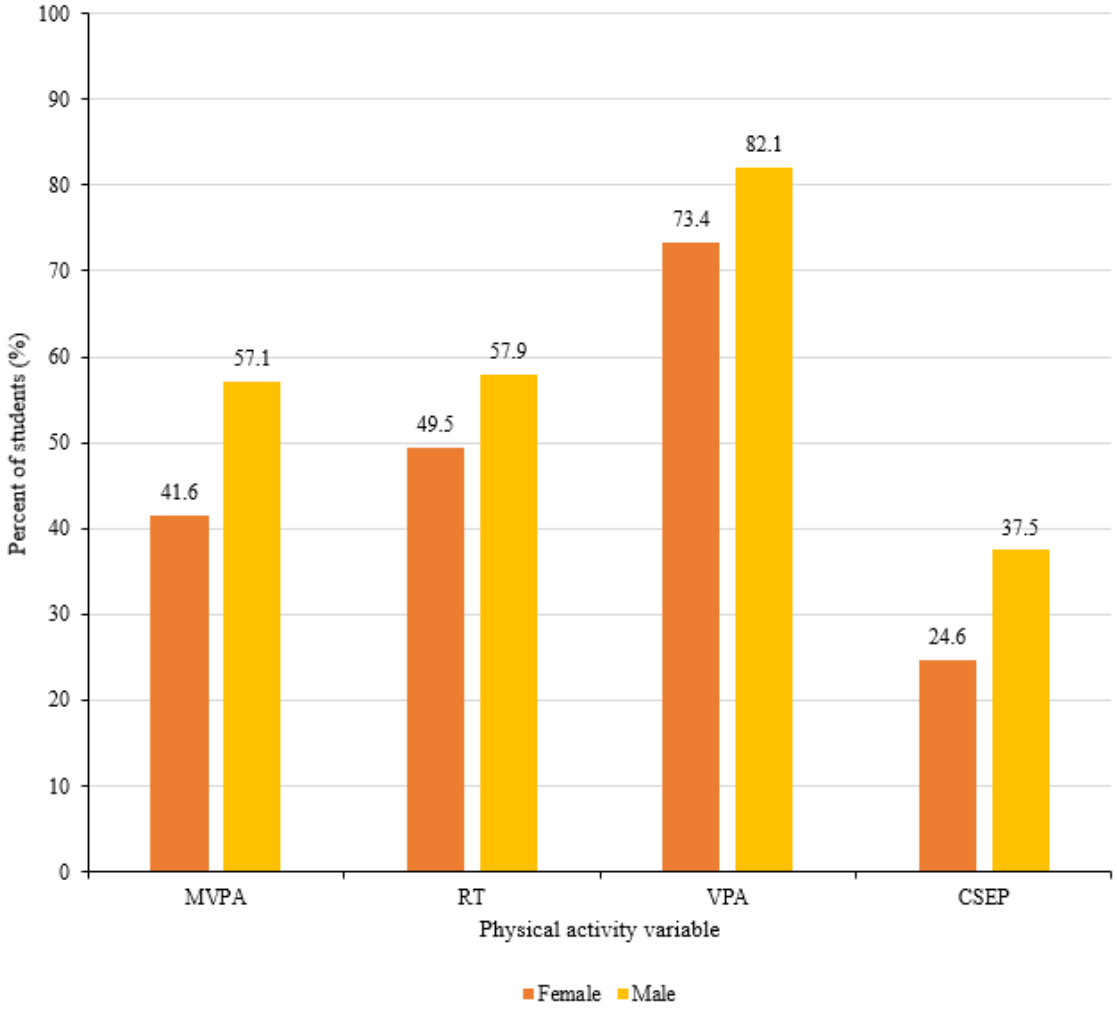
Table 1: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by gender

Variable		Female (n=17672) % (n)	Male (n=17625) % (n)	Total (n=35297) % (n)	Chi Square df
Grade	9	24.8 (4385)	25.8 (4554)	25.3 (8939)	χ^2=8.9** df=3
	10	26.5 (4691)	25.4 (4480)	26.0 (9171)	
	11	25.3 (4467)	25.0 (4403)	25.1 (8870)	
	12	23.4 (4129)	23.8 (4188)	23.6 (8317)	
Ethnicity	White only	76.2 (13464)	74.3 (13093)	75.2 (26557)	χ^2=17.1* df=1
	Other	23.8 (4208)	25.7 (4532)	24.8 (8740)	
Weekly spending money	$0	17.4 (3074)	18.7 (3290)	18.0 (6364)	χ^2=144.1* df=3
	$1-20	33.6 (5936)	32.2 (5681)	32.9 (11617)	
	$21-99	32.7 (5777)	28.6 (5042)	30.7 (10819)	
	>$100	16.3 (2885)	20.5 (3612)	18.4 (6497)	
Current binge drinker	No	77.3 (13654)	72.9 (12853)	75.1 (26507)	χ^2=88.8* df=1
	Yes	22.7 (4018)	27.1 (4772)	24.9 (8790)	
Current marijuana user	No	86.0 (15190)	80.7 (14231)	83.4 (29421)	χ^2=172.7* df=1
	Yes	14.0 (2482)	19.3 (3394)	16.7 (5876)	
Current smoker	No	95.2 (16820)	92.3 (16273)	93.8 (33093)	χ^2=122.4* df=1
	Yes	4.8 (852)	7.7 (1352)	6.2 (2204)	
Eating recommended fruits and vegetables	No	94.0 (16611)	95.3 (16802)	94.7 (33413)	χ^2=31.1* df=1
	Yes	6.0 (1061)	4.7 (823)	5.3 (1884)	
BMI	Missing	19.5 (3439)	18.5 (3251)	19.0 (6690)	χ^2=545.6* df=4
	Underweight	1.4 (243)	1.7 (294)	1.5 (537)	
	Normal	62.9 (11120)	54.1 (9543)	58.5 (20663)	
	Overweight	11.9 (2107)	17.0 (3006)	14.5 (5113)	
	Obese	4.3 (763)	8.7 (1531)	6.5 (2294)	
Sedentary behaviour	No	4.1 (719)	3.1 (551)	3.6 (1270)	χ^2=22.6* df=1
	Yes	95.9 (16953)	96.9 (17074)	96.4 (34027)	
		mean (sd)	mean (sd)	mean (sd)	T-Test df
KKD		8.2 (6.1)	11.0 (7.5)	9.6 (7.0)	T= 37.55* df=33776

Notes: *:p-value of **<0.001, ****:p-value of **<0.05**
MVPA= moderate to vigorous physical activity, RT= resistance training, VPA= vigorous physical activity, CSEP= MVPA+RT+VPA
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days
Satterthwaite t-test, unequal variance

Figure 3 demonstrates that females were less likely than males to report achieving physical activity, including MVPA recommendations, RT at least 3 days per week, VPA at least 3 days per week, meeting the CSEP guidelines and having lower KKD values (p<.001).

Figure 3: Prevalence of different physical activity outcomes among grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by gender



Notes:
Based on data from 35297 students at 89 secondary schools as part of the COMPASS study
MVPA= moderate to vigorous physical activity for at least 60 minutes every day
RT= resistance training at least three days a week
VPA= vigorous physical activity at least three days a week
CSEP= MVPA+RT+VPA
All differences are significant with a $p<0.0001$

5.1.2 Research question 1 a, b: Descriptive results for students achieving physical activity guidelines (MVPA and CSEP)

Table 2 and 3 shows the descriptive statistics for MVPA and CSEP within the Year 2 COMPASS sample. Overall, 49.3% (n=17,407) achieved 60 minutes of MVPA daily and

31.0% (n=10,947) of the sample met the CSEP guidelines. These two physical activity variables showed some similarities. Males were more likely than females to report meeting physical activity guidelines ($p<.001$) and the percent of students who reported achieving physical activity guidelines decreased as grade increased ($p<.001$). Compared to those who did not meet the guidelines, students who met the guidelines for physical activity were more likely to report being current binge drinkers ($p<.001$), being current marijuana users ($p<.001$), and report eating recommended servings of fruits and vegetables ($p<.001$). Students with a BMI classified as overweight were more likely to achieve the physical activity guidelines ($p<.001$).

Variables that varied between MVPA and CSEP were weekly spending money, ethnicity, and current smoking. Appendix C provides descriptive statistics for additional physical activity variables (RT and VPA).

Table 2: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by MVPA (Research question 1a)

		Not meeting 60 minutes MVPA daily? (n=17890) % (n) /	Meeting 60 minutes MVPA daily? (n=17407) % (n)	Total (n=35297) % (n)	Chi Square df
Gender	Female	57.7 (10321)	42.2 (7351)	50.1 (17672)	χ^2=843.6*
	Male	42.3 (7569)	57.8 (10056)	49.9 (17625)	df=1
RT >= 3 days per week?	No	56.9 (10176)	35.5 (6174)	46.3 (16350)	χ^2=1626.8*
	Yes	43.1 (7714)	64.5 (11233)	53.7 (18947)	Df=1
VPA >= 3 days per week?	No	35.9 (6418)	8.3 (1446)	22.3 (7864)	χ^2=3872.2*
	Yes	64.1 (11472)	91.7 (15961)	77.7 (27433)	Df=1
Grade	9	23.4 (4184)	27.3 (4755)	25.3 (8939)	χ^2=98.8*
	10	26.0 (4654)	26.0 (4517)	26.0 (9171)	df=3
	11	25.3 (4533)	24.9 (4337)	25.1 (8870)	
	12	25.3 (4519)	21.8 (3798)	23.6 (8317)	
Ethnicity	White only	73.7 (13181)	76.8 (13376)	75.2 (26557)	χ^2=47.4*
	Other	26.3 (4709)	23.2 (4031)	24.8 (8740)	df=1
Weekly spending money	$0	20.5 (3661)	15.5 (2703)	18.0 (6364)	χ^2=253.6*
	$1-20	33.7 (6036)	32.1 (5581)	32.9 (11617)	df=3
	$21-99	29.9 (5340)	31.5 (5479)	30.7 (10819)	
	>$100	16.0 (2853)	20.9 (3644)	18.4 (6497)	
Current binge drinker	No	78.9 (14111)	71.2 (12396)	75.1 (26507)	χ^2=277.1*
	Yes	21.1 (3779)	28.8 (5011)	24.9 (8790)	df=1
Current marijuana user	No	85.2 (15243)	81.5 (14178)	83.4 (29421)	χ^2=89.6*
	Yes	14.8 (2647)	18.6 (3229)	16.7 (5876)	df=1
Current smoker	No	94.5 (16907)	93.0 (16186)	93.8 (33093)	χ^2=34.8*
	Yes	5.5 (983)	7.0 (1221)	6.2 (2204)	df=1
Eating recommended fruits and vegetables	No	96.1 (17185)	93.2 (16228)	94.7 (33413)	χ^2=140.1*
	Yes	3.9 (705)	6.8 (1179)	5.3 (1884)	df=1
BMI	Missing	20.3 (3628)	17.6 (3062)	19.0 (6690)	χ^2=50.5*
	Underweight	1.6 (284)	1.5 (253)	1.5 (537)	df=4
	Normal	58.0 (10383)	59.1 (10280)	58.5 (20663)	
	Overweight	13.8 (2467)	15.2 (2646)	14.5 (5113)	
	Obese	6.3 (1128)	6.7 (1166)	6.5 (2294)	
Sedentary behaviour	No	3.8 (676)	3.4 (594)	3.6 (1270)	χ^2=3.4
	Yes	96.2 (17214)	96.6 (16813)	96.4 (34027)	df=1
					0.0647
		mean (sd)	mean (sd)	mean (sd)	T-Test df
KKD		5.6 (4.2)	13.7 (6.8)	9.6 (7.0)	T = 133.2 df=28777 **<.001**

Notes: *:p-value of **<0.001**
Satterthwaite t-test, unequal variance
MVPA= moderate to vigorous physical activity, RT= resistance training, VPA= vigorous physical activity, CSEP= MVPA+RT+VPA
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days

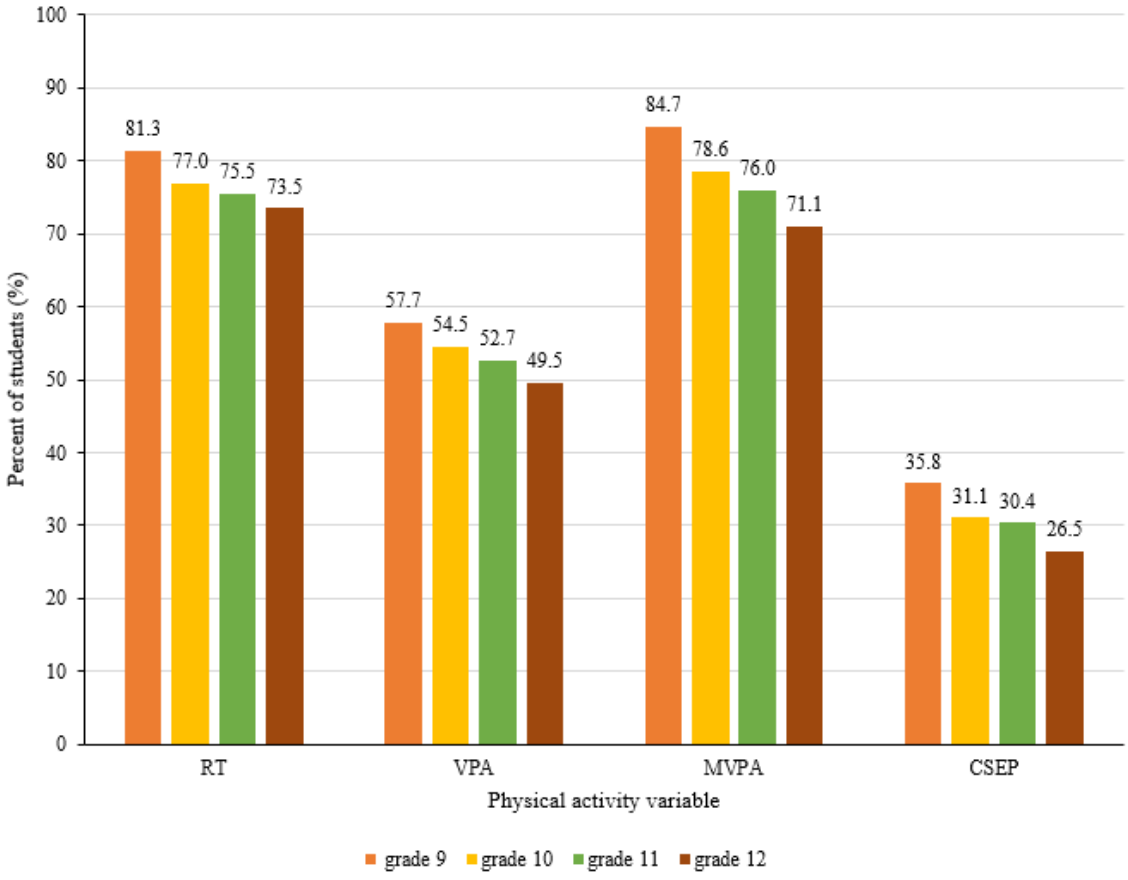
Table 3: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by CSEP (Research question 1b)

		Not meeting CSEP guidelines (n=24350) % (n)	Meeting CSEP guidelines (n=10947) % (n)	Total (n=35297) % (n)	Chi Square df
Gender	Female	54.7 (13325)	39.7 (4347)	50.1 (17672)	χ^2=680.9* df=1
	Male	45.3 (11025)	60.3 (6600)	49.9 (17625)	
Grade	9	23.6 (5740)	29.2 (3199)	25.3 (8939)	χ^2=176.5* df=3
	10	26.0 (6320)	26.0 (2851)	26.0 (9171)	
	11	25.4 (6176)	24.6 (2694)	25.1 (8870)	
	12	25.1 (6114)	20.1 (2203)	23.6 (8317)	
Ethnicity	White only	74.9 (18243)	76.0 (8314)	75.2 (26557)	χ^2=4.3** df=1
	Other	25.1 (6107)	24.1 (2633)	24.8 (8740)	
Weekly spending money	$0	19.8 (4822)	14.1 (1542)	18.0 (6364)	χ^2=241.7* df=3
	$1-20	33.4 (8135)	31.8 (3482)	32.9 (11617)	
	$21-99	29.7 (7238)	32.7 (3581)	30.7 (10819)	
	>$100	17.1 (4155)	21.4 (2342)	18.4 (6497)	
Current binge drinker	No	77.9 (18969)	68.9 (7538)	75.1 (26507)	χ^2=330.2* df=1
	Yes	22.1 (5381)	31.1 (3409)	24.9 (8790)	
Current marijuana user	No	84.6 (20588)	80.7 (8833)	83.4 (29421)	χ^2=81.2* df=1
	Yes	15.5 (3762)	19.3 (2114)	16.7 (5876)	
Current smoker	No	94.0 (22879)	93.3 (10214)	93.8 (33093)	χ^2=5.5** df=1
	Yes	6.0 (1471)	6.7 (733)	6.2 (2204)	
Eating recommended fruits and vegetables	No	96.1 (23394)	91.5 (10019)	94.7 (33413)	χ^2=309.6* df=1
	Yes	3.9 (956)	8.5 (928)	5.3 (1884)	
BMI	Missing	20.7 (5034)	15.1 (1656)	19.0 (6690)	χ^2=201.2* df=4
	Underweight	1.7 (406)	1.2 (131)	1.5 (537)	
	Normal	57.2 (13934)	61.5 (6729)	58.5 (20663)	
	Overweight	13.7 (3329)	16.3 (1784)	14.5 (5113)	
	Obese	6.8 (1647)	5.9 (647)	6.5 (2294)	
Sedentary behaviour	No	3.6 (868)	3.7 (402)	3.6 (1270)	χ^2=0.3 df=1
	Yes	96.4 (23482)	96.3 (10545)	96.4 (34027)	
		mean (sd)	mean (sd)	mean (sd)	T-Test df
KKD		7.1 (5.4)	15.2 (6.8)	9.6 (7.0)	T= 109.7* df=17243

Notes: *:p-value of **<0.001,** **:p-value of **<0.05**
Satterthwaite t-test, unequal variance
MVPA= moderate to vigorous physical activity, RT= resistance training, VPA= vigorous physical activity, CSEP= MVPA+RT+VPA
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days

As shown in Figure 4, each physical activity outcome examined (RT, VPA, MVPA, and CSEP) declined significantly with grade ($p<0.001$).

Figure 4: Prevalence of different physical activity outcomes among grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by grade



Notes:
* Shows a significant decline of physical activity through the grade levels ($p<0.001$).
Based on data from 35297 students at 89 secondary schools as part of the COMPASS study
MVPA= moderate to vigorous physical activity for at least 60 minutes every day
RT= resistance training at least three days a week
VPA= vigorous physical activity at least three days a week
CSEP= MVPA+RT+VPA

5.1.6 Research question 1c: Descriptive results for KKD values of students

As shown in Table 4, the overall mean KKD value of students in the year 2 COMPASS sample was 9.6 kcal/kg/day ±7.0 (range: 0-42.8 kcal/kg/day). Students who reported 0 KKD, answered the MPA and VPA questions by filling in 0. As shown in Figure 5, 1,116 students reported KKD values of 0. A sensitivity analysis was performed excluding students who reported 0 KKD and only minor differences were observed (Appendix D).

Males were more likely to report a higher mean KKD value compared to females ($p<.001$). Students with higher KKD were also more likely to report achieving physical activity, including the recommended amount of MVPA daily, RT at least three days per week, VPA at least three days per week, and the CSEP guidelines ($p<.001$). Mean KKD values tended to decrease as grade increased ($p<.001$) and as the amount of weekly spending money increased so did the mean KKD value ($p<.001$).

Students who were current substance users reported higher mean KKD values ($p<.001$). Substance users included current binge drinkers, current smokers and current marijuana users. The students who reported eating recommended servings of fruits and vegetables also had a higher mean KKD values ($p<.001$). Students who reported heights and weights placing them in the overweight BMI classification had the highest mean KKD value (10.1± 6.9), followed by normal weight (9.8±6.7), then obese individuals (9.4± 7.2). The students classified as underweight reported the lowest mean KKD value (8.7±7.2) and the students whose data was missing (8.8±7.5) were similar to that of the underweight students ($p<.001$). Students who reported being sedentary had a lower mean KKD compared to those who were not sedentary ($p<.001$).

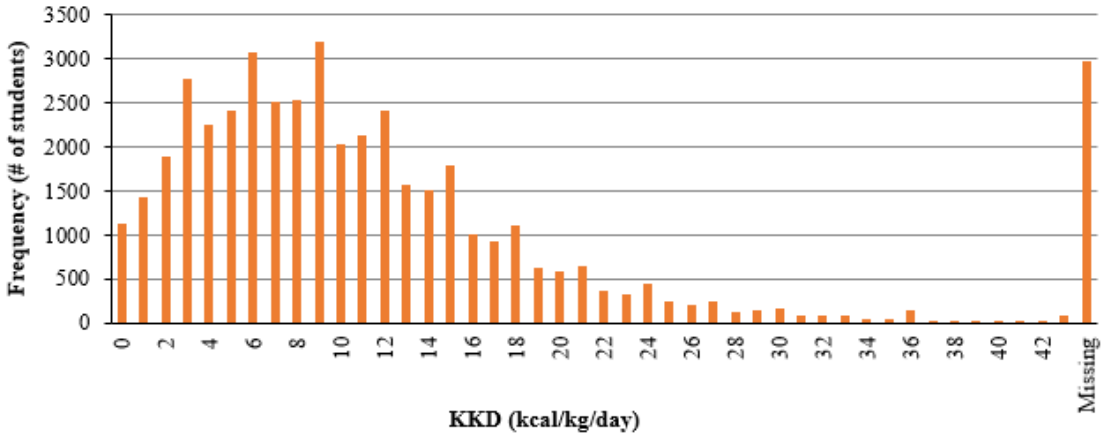
Table 4: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by KKD (Research question 1c)

		N (35297)	Mean (Sd)	Range (min- max)	T-Test/Anova df
Gender	Female	17672	8.3 (6.1)	0-42.75	T =37.6*
	Male	17625	11.0 (7.5)	0-42.75	df=33776
Meeting recommendation of 60 minutes MVPA daily?	No	17890	5.6 (4.2)	0-36.64	T = 133.2*
	Yes	17407	13.7 (6.8)	3-42.75	df=28777
RT >= 3 days per week?	No	16350	7.0 (5.8)	0-42.75	T = 72.2*
	Yes	18947	11.9 (7.0)	0-42.75	df= 35241
VPA >= 3 days per week?	No	7864	3.1 (2.8)	0-19.7	T = 165.1*
	Yes	27433	11.5 (6.7)	0.6 – 42.8	df= 31057
Meeting CSEP guidelines?	No	24350	7.1 (5.4)	0-42.75	T= 109.7*
	Yes	10947	15.2 (6.8)	3.6-42.75	df=17243
Grade	9	8939	10.5 (7.0)	0-42.75	
	10	9171	9.6 (6.9)	0-42.75	F=85.4*
	11	8870	9.5 (7.1)	0-42.75	df=3
	12	8317	8.9 (6.8)	0-42.75	
Ethnicity	White only	26557	9.6 (6.8)	0-42.75	T=1.4
	Other	8740	9.5 (7.5)	0-42.75	df=13724
Weekly spending money	$0	6364	8.3 (6.8)	0-42.75	
	$1-20	11617	9.2 (6.5)	0-42.75	F = 196.2*
	$21-99	10819	9.9 (6.7)	0-42.75	df=3
	>$100	6497	11.1 (8.0)	0-42.75	
Current binge drinker	No	26507	9.1 (6.6)	0-42.75	T = 22.8*
	Yes	8790	11.2 (7.7)	0-42.75	df= 13357
Current marijuana user	No	29421	9.4 (6.7)	0-42.75	T = 10.7*
	Yes	5876	10.6 (8.0)	0-42.75	df= 7607
Current smoker	No	33093	9.5 (6.8)	0-42.75	T = 6.8*
	Yes	2204	10.9 (9.2)	0-42.75	df=2364
Eating recommended fruit and vegetables	No	33413	9.4 (6.7)	0-42.75	T = 19.2*
	Yes	1884	13.5 (9.2)	0-42.75	df=2000
BMI	Missing	6690	8.8 (7.5)	0-42.75	
	Underweight	537	8.7 (7.2)	0-42.75	F = 36.6*
	Normal	20663	9.8 (6.7)	0-42.75	df=4
	Overweight	5113	10.1 (6.9)	0-42.75	
	Obese	2294	9.4 (7.2)	0-42.75	
Sedentary behaviour	No	1270	10.6 (8.1)	0-42.75	T= 4.3*
	Yes	34027	9.6 (6.9)	0-42.75	df=1339
Total		35297	9.6 (7.0)	0-42.75	

Notes: *:p-value of <0.001
Satterthwaite t-test, unequal variance
MVPA= moderate to vigorous physical activity, RT= resistance training, VPA= vigorous physical activity,
CSEP= MVPA+RT+VPA
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days

Figure 5, demonstrates the distribution of KKD values. The figure demonstrates a clustering of students between 0 and 18kcal/kg/day. Not as many students achieved values of 19-42.75 kcal/kg/day.

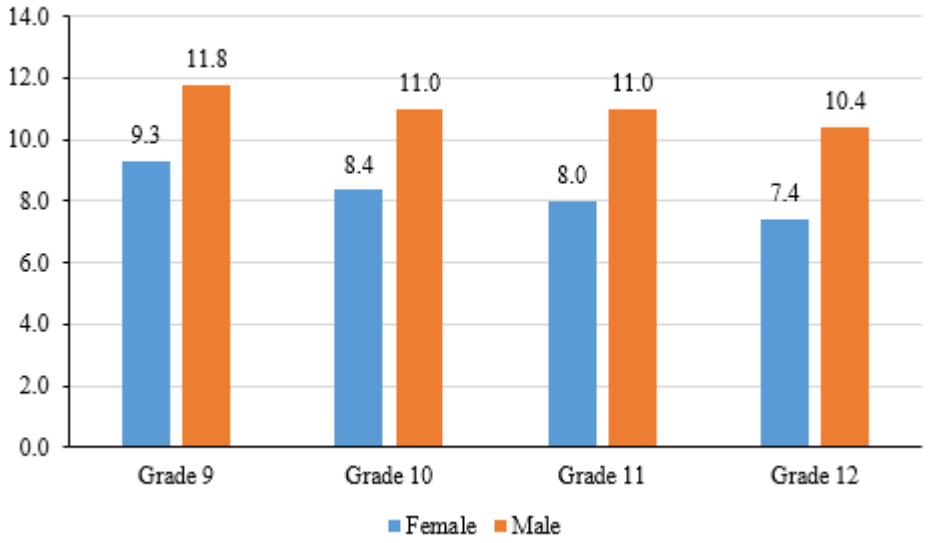
Figure 5: KKD among grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by frequency



Notes:
0 value was reported as such, missing data is shown on the figure and was removed during analysis
Based on data from 35297 students at 89 secondary schools as part of the COMPASS study
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days

As shown in Figure 6, KKD values were lower in females than in males and the mean values decreased as grade increased ($p<0.001$).

Figure 6: Mean KKD among grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by gender and grade



Notes:
0 values was reported as such, missing data was removed during analysis
Based on data from 35297 students at 89 secondary schools as part of the COMPASS study
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days
All differences are significant with a $p<0.0001$

5.2 Descriptive results for school-level characteristics

When examining the school-level, the schools' mean physical activity prevalence is very similar to the students' prevalence. The mean school-level prevalence of students who reported meeting the MVPA recommendation was 50% (5 schools reported a mean between 30-40%, 34 schools reported a mean between 40-50%, 46 schools reported a mean between 50-60%, and 4 schools reported a mean between 60-70%). The mean school-level prevalence of students who reported meeting the CSEP guidelines per school was 31% (1 school reported a mean between 10-20%, 37 schools reported a mean between 20-30%, 49 schools reported a mean between 30-40%, and 2 schools reported a mean between 40-50%). The mean KKD per school was 9.7 kcal/kg/day ± 7.0 (18 schools reported a mean between 7-9

kcal/kg/day, 42 schools reported a mean between 9-10 kcal/kg/day, 25 schools reported a mean between 10-11 kcal/kg/day, 4 schools reported a mean between 11-13 kcal/kg/day).

5.2.1 Descriptive results for facilities among schools in the COMPASS study

As shown in Table 5, the mean number of facilities per school was 5.4±2.5 (range 2 to 16), with 2.6±1.2 (range 1 to 9) being indoor and 2.8±1.7 (range 0 to 9) being outdoors. The average condition of all facilities were generally between good and average, with a mean score of 2.6 ±0.4.

Most schools (86.5%) provided access to outdoor facilities during non-instructional time. Similarly 87.6% of schools allowed students access to equipment during non-instructional times and 69.7% of schools allowed access to indoor facilities during non-instructional time. Resulting in an overall average of 2.5±0.8 out of 3 for facility access during non-instructional time.

An accessibility score was created using questions regarding the presence of 13 facilities and resources that aid in physical activity (access to showers, lockers, facilities etc.). Each question that the school answered in the affirmative added to their score out of 13. The mean score for the 89 sampled schools was 9.9 ± 2.2.

5.2.2 Descriptive results for school size among schools in the COMPASS study

As shown in Table 5, 21 schools (23.6%) had 500 students or less and were classified as “small”, 52 schools (58.4%) had between 501 and 1,000 students and were classified as “medium” and 16 schools (18.0%) had over 1,000 students and were classified as “large”. Large schools had the highest mean number of facilities (6.1 ±2.1) compared to small with 5.7 ±3.3 and medium with 5.1±2.3 ($p<0.001$). The medium sized schools had the best access to facilities (10.3±1.8) compared to small (9.7±0.2) and large schools (8.7±3.1) ($p<0.001$).

And the small schools had the worst average condition (2.4±0.5), compared to medium schools (2.7±0.3) and large schools (2.7±0.4) ($p<0.001$).

Table 5: Descriptive statistics for the 89 schools in the Year 2 (2013-2014) sample of the COMPASS study by school size

	School size (number of students enrolled)			
Variable	≤500 (n=21) mean (sd)	501-1000 (n=52) mean (sd)	>1000 (n=16) mean (sd)	Total (n=89) mean (sd)
Number of indoor facilities	2.5 (1.6)	2.6 (1.2)	2.7 (0.8)	2.6 (1.2)
Number of outdoor facilities	3.1 (2.3)	2.6 (1.4)	3.4 (1.8)	2.8 (1.7)
Total number of facilities	5.7 (3.3)	5.1 (2.3)	6.1 (2.1)	5.4 (2.5)
Average condition of facilities [a]	2.4 (0.5)	2.7 (0.3)	2.7 (0.4)	2.6 (0.4)
Facility access during non-instructional time [b]	2.7 (0.7)	2.6 (0.6)	1.7 (1)	2.5 (0.8)
Accessibility score [c]	9.7 (2.0)	10.3 (1.8)	8.7 (3.1)	9.9 (2.2)

Based on data from 89 secondary schools
a= Facilities that were not rated were not included in the average
b= Access to indoor facilities, outdoor facilities and equipment were added together to give a maximum of 3 (only looks at 88 schools due to missing data). Missing data was counted as a "no" unless all were missing.
c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing.

5.2.3 Descriptive results for school location among schools in the COMPASS study

As shown in Table 6, there were 3 schools (3.4%) classified as rural, 43 schools (48.3%) classified as small urban, 14 schools (15.7%) classified as medium urban and 29 schools (32.6%) classified as large urban.

In terms of total facilities, schools in a large or small urban centres had the highest mean number of facilities (5.9 ± 3.4 and 5.4 ± 2.2 respectively vs. medium with 4.6±1.4 and rural with 4.7±1.5). Large urban centers had the highest mean indoor facilities (2.9±1.7) however rural schools had the highest mean outdoor facilities (3.0 ±1).

The mean facility condition decreased slightly as schools were in smaller and rural cities or towns (large urban 2.7±0.3 to 2.3±0.6 rural). Access during non-instructional times showed the opposite trend (large urban 2.1±0.8 to 2.7±0.6 rural). However, when examining the total accessibility score rural schools had the lowest (8.7±1.5) and medium urban centres had the highest at 11.2±1.9 out of 13.

Table 6: Descriptive statistics for the 89 schools in the Year 2 (2013-2014) sample of the COMPASS study by school location

	School location				
Variable	Rural (n=3) mean (sd)	Small Urban (n=43) mean (sd)	Medium Urban (n=14) mean (sd)	Large Urban (n=29) mean (sd)	Total (n=89) mean (sd)
Number of indoor facilities	1.7 (0.6)	2.5 (0.9)	2.4 (0.8)	2.9 (1.7)	2.6 (1.2)
Number of outdoor facilities	3 (1)	2.9 (1.8)	2.3 (1.1)	3.0 (1.9)	2.8 (1.7)
Total number of facilities	4.7 (1.5)	5.4 (2.2)	4.6 (1.4)	5.9 (3.4)	5.4 (2.5)
Average condition of facilities [a]	2.3 (0.6)	2.5 (0.4)	2.7 (0.4)	2.7 (0.3)	2.6 (0.4)
Facility access during non-instructional time [b]	2.7 (0.6)	2.6 (0.7)	2.6 (0.6)	2.1 (0.8)	2.5 (0.8)
Accessibility score [c]	8.7 (1.5)	10.0 (2.2)	11.2 (1.9)	9.2 (2.1)	9.9 (2.2)

*Location based on the Canadian census classifications used in 2011
Based on data from 89 secondary schools
a= Facilities that were not rated were not included in the average
b= Access to indoor facilities, outdoor facilities and equipment were added together to give a maximum of 3 (only looks at 88 schools due to missing data). Missing data was counted as a "no" unless all were missing.
c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing

5.2.4 Descriptive results for school type among schools in the COMPASS study

As shown in Table 7, within the COMPASS Year 2 data, there were 6 private schools (6.7%) included in the sample and 83 public schools (93.3%) (Catholic and Public school boards). Private schools had an average of almost double the number the facilities as public schools (9.3±5.5 vs 5.1±1.9), but the conditions of the facilities were very similar (2.8±0.2 vs 2.6±0.4). Access appeared to be better on average in the private schools with all private schools allowing access to indoor and outdoor facilities and equipment during non-instructional time. Private schools had an accessibility score of 10.5(±1.6) vs 9.8(±2.2) for public schools out of a possible 13.

Table 7: Descriptive statistics for the 89 schools in the Year 2 (2013-2014) sample of the COMPASS study by school type

	School Type		
Variable	Private (n=6) mean (sd)	Public (n=83) mean (sd)	Total (n=89) mean (sd)
Number of indoor facilities	4.8 (3.0)	2.4 (0.8)	2.6 (1.2)
Number of outdoor facilities	4.5 (2.6)	2.7 (1.6)	2.8 (1.7)
Total number of facilities	9.3 (5.5)	5.1 (1.9)	5.4 (2.5)
Average condition of facilities [a]	2.8 (0.2)	2.6 (0.4)	2.6 (0.4)
Facility access during non-instructional time [b]	3.0 (0)	2.4 (0.8)	2.5 (0.8)
Accessibility score [c]	10.5 (1.6)	9.8 (2.2)	9.9 (2.2)

Based on data from 89 secondary schools
a= Facilities that were not rated were not included in the average
b= Access to indoor facilities, outdoor facilities and equipment were added together to give a maximum of 3 (only looks at 88 schools due to missing data). Missing data was counted as a "no" unless all were missing.
c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing

5.3 Multilevel modeling results for school and student level characteristics in the COMPASS study

5.3.1 Research question 2: Variability between schools for physical activity

The between school variability for physical activity was small, as shown by the intra-class correlation coefficients (ICC) (Table 8) for all of the outcome variables. The ICC values all have a p-value of <0.001 and are significant, however the ICCs are small representing only 1.1% for MVPA, 0.8% for CSEP and 1.2% for KKD of the variability in students' time spent in physical activity.

Table 8: Intra-class correlation coefficients for physical activity among the Year 2 COMPASS schools (Research question 2)

Variable		Estimate (se)	ICC	P-value
MVPA	variance in level 2 random effect	0.038 (0.008)	0.011	<0.001
CSEP	variance in level 2 random effect	0.028 (0.006)	0.008	<0.001
KKD	variance in level 2 random effect	0.558 (0.106)		
	variance in level 1 random effect	47.823 (0.360)	0.012	<0.001

*Based on data from 35297 students at 89 secondary schools as part of the Year 2 COMPASS study

5.3.2 Research question 3: School level characteristics associated with physical activity in the COMPASS study

In order to answer research question 3, a univariate analysis was preformed (results are displayed in Appendix E). Each school level variable that was identified as significant in the univariate analysis was also examined in a multivariate analysis (results are displayed in Appendix E). Interaction terms were explored, however none were found to be significant. Correlations between variables were examined and the results can be found in Appendix E, however the correlations do not affect the results.

When controlling for significant school level characteristics youth who attended a private school were less likely to achieve the MVPA recommendation than those who

attended a public school (OR 0.81, 95% CI 0.67 to 0.98). Students attending a school with a higher accessibility score were less likely to achieve the CSEP guidelines (OR 0.97, 95%CI 0.95 to 0.99). Finally, when controlling for significant school level characteristics youth who attended a medium urban school were more likely to achieve the CSEP guidelines than those who attended a large urban school (Est. 0.53, se 0.27, $p<0.05$).

5.3.4 Research question 4: School and student level characteristics associated with physical activity in the COMPASS study

Table 9 shows a multivariate analysis of the association between significant school level characteristics and physical activity measured by MVPA, CSEP and KKD for the Year 2 COMPASS schools controlling for student level characteristics. Table 9 shows the odds ratios and estimate of each significant school and student level characteristics associated with the physical activity outcomes.

Table 9: Multivariate analysis of the association between school level characteristics and physical activity measured by MVPA, CSEP and KKD for the Year 2 COMPASS schools controlling for student level characteristics (Research question 4)

Variable (Reference group)		MVPA		CSEP		KKD	
		OR (95% CI)	p-value	OR (95% CI)	p-value	EST (SE)	p-value
School type (REF= Public)	Private	**0.76 (0.65, 0.89)**	<.001		N/A		N/A
School location (REF= Large Urban)	Rural		N/A		N/A	0.32 (0.47)	0.48
	Small Urban		N/A		N/A	0.17 (0.16)	0.31
	Medium Urban		N/A		N/A	0.36 (0.22)	0.09
Accessibility score [c]	1 unit change		N/A	**0.97 (0.95, 0.99)**	<.001		N/A
Grade (REF=9)	10	**0.77 (0.73, 0.82)**	<.001	**0.71 (0.66, 0.76)**	<.001	-1.41 (0.10)	**<.001**
	11	**0.70 (0.65, 0.74)**	<.001	**0.60 (0.56, 0.65)**	<.001	-2.00 (0.10)	**<.001**
	12	**0.56 (0.52, 0.60)**	<.001	**0.45 (0.42, 0.48)**	<.001	-2.98 (0.11)	**<.001**
Gender (REF=Female)	Male	**1.88 (1.80, 1.96)**	<.001	**1.88 (1.79, 1.97)**	<.001	2.69 (0.07)	**<.001**
Ethnicity (REF= White only)	Other	**0.86 (0.81, 0.90)**	<.001	**0.94 (0.89, 1.00)**	0.04	0.05 (0.09)	0.54
Weekly spending money (REF=$0)	$1-20	**1.24 (1.16, 1.32)**	<.001	**1.31 (1.21, 1.41)**	<.001	0.86 (0.10)	**<.001**
	$21-99	**1.43 (1.34, 1.53)**	<.001	**1.60 (1.49, 1.73)**	<.001	1.72 (0.11)	**<.001**
	>$100	**1.70 (1.57, 1.83)**	<.001	**1.82 (1.67, 1.98)**	<.001	2.65 (0.12)	**<.001**
Current binge drinker (REF=No)	Yes	**1.42 (1.34, 1.51)**	<.001	**1.64 (1.54, 1.74)**	<.001	1.84 (0.09)	**<.001**
Current marijuana user (REF=No)	Yes	1.07 (1.00, 1.14)	0.06	1.06 (0.98, 1.14)	0.13	0.02 (0.11)	0.86
Current smoker (REF=No)	Yes	1.02 (0.92, 1.12)	0.74	**0.86 (0.78, 0.96)**	0.007	0.20 (0.16)	0.21
Eating recommended fruits and vegetables (REF=Yes)	No	**0.55 (0.50, 0.61)**	<.001	**0.43 (0.32, 0.48)**	<.001	-3.91 (0.16)	**<.001**
BMI (REF=Normal)	Underweight	0.90 (0.75, 1.08)	0.25	**0.67 (0.55, 0.83)**	<.001	-1.01 (0.29)	**<.001**
	Overweight	0.99 (0.93, 1.05)	0.66	1.01 (0.95, 1.08)	0.72	-0.10 (0.10)	0.33
	Obese	0.92 (0.84, 1.01)	0.08	**0.72 (0.65, 0.79)**	<.001	-0.96 (0.15)	**<.001**
	Missing	**0.84 (0.79, 0.89)**	<.001	**0.66 (0.61, 0.70)**	<.001	-1.10 (0.09)	**<.001**
Sedentary behaviour (REF=No)	Yes	1.09 (0.97, 1.23)	0.13	0.95 (0.83, 1.07)	0.38	-0.96 (0.19)	**<.001**

Based on data from 35297 students at 89 secondary schools as part of the Year 2 COMPASS study
*Students with missing values for any characteristic except for BMI were excluded from the analysis and table.
c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing.
N/A= variables were not included in the model
MVPA= achieve 60 min every day of moderate to vigorous physical activity (Yes=1 or No=0)
CSEP= achieve MVPA, as well as VPA and RT 3 days per week (Yes=1 or No=0)
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days – one unit changes represented.
*Final models improved fit over the ICC models according to AIC values.

5.3.4.1 Student- and school-level factors associated with MVPA among students in the COMPASS study

As shown in Table 9, students who went to a private school were less likely to achieve the MVPA recommendation compared to students who attended a public school even when controlling for student-level characteristics.

Students who achieved the MVPA recommendation were more likely to be male, white only, a current binge drinker and eating recommended servings of fruits and vegetables (Table 9). As grade increased physical activity decreased (relative to a student in grade 9, students in grade 10, grade 11 and grade 12 were less likely to achieve the MVPA recommendation). Students who had more weekly spending money were more likely to achieve the MVPA recommendation (relative to a student with $0 of weekly spending money, students with weekly spending money of $1-, $21-99 and >$100 were more likely to achieve the MVPA recommendation.) Finally, self-reported BMI was not significantly associated with MVPA, however students who didn't self-report either their height or weight on the questionnaire and were classified as "missing" for BMI were less likely to achieve the MVPA recommendation than normal weight individuals.

5.3.4.2 Student- and school-level factors associated with CSEP among students in the COMPASS study

As shown in Table 9, students who went to a school with a higher accessibility score were less likely to achieve the CSEP guidelines compared to students who attended a school with a lower accessibility score, even when controlling for student-level characteristics.

Students who achieved the CSEP guideline were more likely to be male, white only, a current binge drinker, not a current smoker and eating recommended servings of fruits and

vegetables (Table 9). As grade increased physical activity decreased (relative to a student in grade 9, students in grade 10, grade 11 and grade 12 were less likely to achieve the CSEP guidelines). Students who had more weekly spending money were more likely to achieve the CSEP guidelines (relative to a student with $0 of weekly spending money, students with weekly spending money of $1-20, $21-99 and >$100 were more likely to achieve the CSEP guidelines). Finally, students who didn't self-report either their height or weight on the questionnaire and were classified as "missing" for BMI were least likely to achieve the CSEP guideline than normal weight individuals.

5.3.4.3 Student- and school-level factors associated with KKD among students in the COMPASS study

As shown in Table 9, no school level characteristic is significant when accounting for all student level characteristics.

Students who achieved higher KKD values were more likely to be male, a current binge drinker, not a current smoker, eating recommended servings of fruits and vegetables and sedentary (Table 9). As grade increased physical activity decreased (relative to students in grade 9, students in grade 10, grade 11 and grade 12 were more likely to have lower mean KKD values). Students who had more weekly spending money were more likely to have higher KKD values (relative to a student with $0 of weekly spending money, students with weekly spending money of $1-20, $21-99 and >$100 were more likely to have higher mean KKD values.) Finally, students who didn't self-report either their height or weight on the questionnaire and were classified as "missing" for BMI were least likely to achieve the higher KKD values than normal weight individuals.

Chapter 6: Discussion

This study identified that the majority of youth in the Year 2 sample of COMPASS did not participate in sufficient amounts of physical activity. When examining three different variables of physical activity (MVPA recommendation, CSEP guidelines, KKD), the students in this sample were consistently not achieving recommended levels of physical activity. It was also identified within this study that while the school environment was modestly associated with variability in the three physical activity outcomes examined, it appears that student-level characteristics played a larger role in the COMPASS respondents' physical activity levels.

6.1 Physical activity prevalence

Youth physical activity remains an important issue with less than half of the students in the Year 2 COMPASS sample achieving 60 minutes of MVPA every day (49.3%) and less than a third (31.0%) achieving the entire CSEP guidelines. These results are consistent with previous self-report research from the Year 1 COMPASS data. Leatherdale (2015) found that 53.1% of Ontario secondary school students in the sample were not achieving 60 minutes of MVPA every day and VPA 3 days per week. When compared to accelerometer studies [Colley et al., 2011] the self-report values are much higher (7% vs. 49.3%) and demonstrates the over reporting that takes place when using self-report data and is important to consider while interpreting the current study's results. However even with an over-estimation, the majority of youth are not getting enough physical activity to achieve the health benefits associated with physical activity. The CSEP guideline was created to set a minimum level of physical activity that youth need to achieve the health benefits associated with physical

activity [Janssen & LeBlanc, 2010] and the self-report percentage of students meeting it is very low (31.0%), and is potentially even lower in reality due to over-reporting.

6.2 Between school variability in physical activity

The examination of students' physical activity levels in Year 2 of the COMPASS study showed little between school variability in physical activity (1.1% for MVPA, 0.8% for CSEP and 1.2% for KKD). The low between school variability was supported by the fact that the school level mean prevalence of physical activity was consistent and very similar to the prevalence of students' physical activity levels (MVPA: 50% vs. 49.3%, CSEP: 31% vs. 31.0%, KKD: 9.7kcal/kg/day vs. 9.6kcal/kg/day, respectively). The low variability in schools for physical activity means that schools are not influencing physical activity levels and instead student characteristics seem to be more important in this sample. Modest between school variability for self-reported minutes in MVPA has been identified for Canadian secondary school students previously (3.0%) [Hobin et al, 2012] and studies examining physical activity of elementary and middle school students have identified between school variability from not significant up to 25.9% [Faulkner et al., 2014; Leatherdale et al., 2010; Kristensen et al., 2013]. The current study used different variable definitions and sample size compared to previous research and showed smaller variability between schools (0.8% to 1.2%). However, the current study adds to the limited body of literature that demonstrates that between school variability is small for self-reported physical activity of secondary school students in Canada. Although the variability is small, schools may be a good environment to promote and encourage physical activity and for physical activity interventions but the limited between school variability makes it difficult to identify specific interventions or facilities that may increase physical activity levels.

In the future identifying schools that have high physical activity levels and comparing them to those who have low physical activity levels may be a way to identify differences in the school environment. For example, looking at the top and bottom 25% of schools for mean physical activity to determine if there are differences in the school environment as there would be more variability to explain. Future studies could also use different physical activity measures to examine between school variability (objective measures of physical activity or school time physical activity) as different measures may demonstrate higher variability in physical activity between schools. The ecological model should also be further explored, when examining total physical activity, such as the social, home and neighbourhood environments [Sallis et al., 2006], as each environment has the potential to influence physical activity.

6.3 School level characteristics associated with physical activity in Year 2 of COMPASS

Although, the ecological model identifies the school environment and various school level characteristics as important to physical activity [Sallis et al., 2006], the current study found very few school level characteristics to be significantly associated with students' physical activity levels. The small number of significant school level characteristics was consistent with previous research on secondary school students [Hobin et al, 2012; Fein et al., 2004; Nichol et al., 2009; Button et al., 2013].

Interestingly, for each physical activity variable examined, different school level characteristics were significant in the final models. Three different physical activity variables were used in the current study to attempt to get a broader picture of physical activity. The MVPA variable gives a good idea of students who are getting sufficient physical activity every single day and was associated with school type, suggesting that private school students

are less likely to be getting sufficient physical activity daily compared to public school students. The CSEP variable was used to examine students who met the entire recommendation and was found to be negatively associated with accessibility, which was surprising as it was hypothesized that having facilities more accessible to students would increase their opportunity to get resistance and vigorous exercise and thus the entire CSEP guideline. It is possible that if accessibility was measured using student perceptions instead of administrator surveys, the results would have been as hypothesized. The CSEP guidelines are not regularly examined in the literature but are what youth need in order to achieve all of the health benefits associated with physical activity [Janssen & LeBlanc, 2010]. Finally, KKD was used to examine physical activity in a continuous variable to get an overall understanding of physical activity levels of students and is consistent with recent literature [Leatherdale & Wong, 2008; Leatherdale et al., 2008; Leatherdale, Faulkner & Arbour-Nicitopoulos 2010]. Although KKD had the greatest between school variability, KKD was not associated with any school level factors when controlling for student level variables, which suggests that the measured school level variables are not the ones associated with KKD and other school level variables such as type of facility, sports teams or physical education classes may be important to include in future studies.

Hypotheses based on research by Fein et al. (2004) and Nichol et al. (2009) were that increased access to facilities during non-instructional times and the quality of facilities would increase physical activity, however, neither were significant in any models. If the accessibility of facilities during non-instructional times was measured using student questionnaires instead of by administrators it is possible that the results would have differed, because students' perceptions are important [Sallis et al, 2006]. For example, to use facilities

students need to feel that they are accessible to them. The quality of facilities not being significant may be explained by the consistently found 'good' or 'average' conditions of school facilities. The lack of variability in facility quality ratings may have contributed to the difficulty identifying significant differences between schools. Missing information on the quality of some facilities (e.g., outdoor fields missing a quality rating due to snow coverage) could have also contributed to the null findings. Future research using a more detailed quality rating instrument and observing outdoor facilities when they are not snow covered is warranted, as this may identify different relationships with physical activity.

Previous studies have found the number of facilities [Nichol et al., 2009; Button et al., 2013] to be significantly associated with youth physical activity, however the current study did not. The differences in findings may be due to the fact that the current study examined total physical activity during the week and not physical activity during the school day. It is possible that if the current study was to examine physical activity during the school day only, that there would be more significant associations between physical activity and the school facilities.

Overall, the current study found limited between school variability and few school level characteristics were significant for students' physical activity levels. Future studies should examine each facility individually, use a more detailed measure for quality and attempt to get students perceptions of accessibility instead of the school administrator's perceptions, in order to examine the associations with physical activity. If future studies are only interested in the school environment it may also be important to only examine school day physical activity instead of total physical activity. In the current study, student level characteristics were also examined and found to be significantly associated with physical

activity. Future studies should examine specific subgroups to determine if their physical activity would be associated with more school facilities.

6.4 Student level characteristics associated with physical activity in Year 2 of COMPASS

When controlling for school level characteristics, many student level characteristics were found to be significantly associated with physical activity of youth in the Year 2 sample of COMPASS.

6.4.1 Modifiable Characteristics

Students who reported being current binge drinkers had higher levels of physical activity across all three outcome variables (MVPA, CSEP, and KKD). There is a substantial body of literature that suggests that physical activity or sports are positively associated with binge drinking or alcohol use [Lisha & Sussman, 2010; Terry-McElrath, & O'Malley, 2011; Terry-McElrath et al., 2011; Kwan, Bobko, Faulkner, Donnelly & Cairney, 2014]. Lisha & Sussman (2010), suggests reasons for the association between team sports and alcohol use such as social pressure, competitive nature and stress. There are social norms associated with binge drinking and team sports, which may affect the relationship. Youth who engage in team sports tend to overestimate how much their peers are drinking, and they are constantly bombarded with alcohol advertisements when watching professional sports [Lisha & Sussman, 2010]. The question about team sports participation in the COMPASS survey was not examined; therefore it is possible that the association between alcohol and team sports is the reason that binge drinking was associated with physical activity in the current study. An additional study should be completed using the COMPASS data to specifically examine the relationship between binge drinking and team sports in secondary school students

(descriptive statistics for team sports can be found in Appendix F). A question worth answering in future COMPASS research is whether or not students are achieving physical activity guidelines due to team sports as this may inform the association with binge drinking. It will also be important in future research to examine interventions targeting binge drinking to determine if they impact physical activity levels, as well as to examine interventions targeting physical activity to determine if they are having a negative effect on binge drinking rates.

Current smoking status was significantly negatively associated with youth achieving the CSEP guideline. Current smokers being less likely to achieve sufficient physical activity is consistent with previous literature done on smoking [Audrain-McGovern, et al., 2013; Terry-McElrath et al., 2011; Lisha & Sussman, 2010; deRuiter et al., 2014; Laaksonen et al., 2002; Terry-McElrath, & O'Malley, 2011]. The current study did not find any significant associations between being a current smoker and achieving the MVPA recommendation or having higher KKD values. The null results for MVPA and KKD conflicts with the previous literature. The prevalence of students who identified as current smokers was 6.2%, which is fairly consistent with previous literature [Leatherdale & Rynard, 2013; Leatherdale, 2015]. The negative association between smoking and CSEP adds to the body of research that suggests that smoking decreases the likelihood of being physically active [Lisha & Sussman, 2010; Leatherdale, Wong, Manske & Colditz, 2008, Leatherdale 2008]. Examining why MVPA and KKD were not significantly associated with smoking is an opportunity for future research, it is possible that smokers are getting enough moderate physical activity to not differ from non-smokers in this area, but when vigorous physical activity or resistance exercise is necessary to meet the CSEP guidelines the smokers are more likely to not achieve

it. Identifying the reason for the difference between CSEP and MVPA/KKD may inform interventions to increase levels of current smokers who meet the CSEP guidelines and therefore achieve the health benefits associated with physical activity.

Current marijuana use was not significantly associated with any physical activity variables in the analysis, which differs from research [Terry-McElrath et al., 2011; Lisha & Sussman, 2010; Terry-McElrath, & O'Malley, 2011; Kwan et al., 2014] that current marijuana users achieve less physical activity. The prevalence of students who identified themselves as current marijuana users was 16.7%, which is fairly consistent with previous literature [Leatherdale & Rynard, 2013; Leatherdale, 2015]. In previous literature on the negative association between marijuana use and physical activity, Lisha & Sussman (2010) suggests that drug use is against social norms of athletes but that the relationship might be moderated by both gender and specific sport participation. In future studies examining marijuana use and physical activity it may be important to examine gender and sport participation to determine if these variables would in fact moderate the relationship.

Consistent with research [Pearson et al., 2009; Peltzer & Pengpid, 2012; Laaksonen et al., 2002] students who do not consume recommended servings of fruit and vegetables had lower physical activity levels across all three variables. Very few students consumed the recommended servings of fruit and vegetables (5.3%), which is consistent with previous literature [Leatherdale & Rynard, 2013; Leatherdale, 2015]. Due to the low levels of students consuming recommended servings of fruits and vegetables, future research needs to examine why these levels are so low, identify barriers to eating recommended amounts of fruits and vegetables and evaluate interventions to address this risk factor for chronic disease.

Across all three physical activity outcome variables, overweight students did not differ from normal BMI students and those who did not report their height and/or weight were the least likely to achieve physical activity compared to normal BMI students. For CSEP and KKD, underweight and obese students were also less likely to achieve physical activity than normal BMI students (descriptive statistics table Appendix G). The lack of difference between normal weight and overweight is consistent with a similar previous study by Hobin et al., (2012). Selection bias was evident in that missing BMI data was significantly negatively associated with all three physical activity variables. The missing BMI data is consistent with work done by Arbour-Nicitopoulos, Faulkner & Leatherdale (2010) with children aged 9-14, who found that children who did not report either height or weight were more likely to achieve less KKD as well as being more likely to be female and of non-white ethnicity. In the study by Arbour-Nicitopoulos, Faulkner & Leatherdale, they discussed that there were different types of non-responders: the motivated non-responder and the unmotivated non-responder. This premise may hold true at the secondary school level as well with students purposefully not reporting their height or weight due to concerns (motivated non-responder) or students may not know their height or weight (unmotivated non-responder). The students who are not as likely to report height or weight as motivated non-responders could be the focus of future interventions to increase physical activity, as they may be truly less physically active. Future studies using COMPASS data should examine the difference between unmotivated non-responders and motivated non-responders to more thoroughly examine the response bias for BMI.

Finally, although low physical activity levels have been shown to be associated with sedentary behaviour [Pearson et al., 2014; Leatherdale & Wong, 2008; Leatherdale & Harvey,

2015], in the current study, sedentary behaviour was only significantly negatively associated with KKD. The research by Leatherdale & Wong (2008) noted that active males were less likely to be sedentary but active females were more likely to be sedentary. Because both genders were considered together in the current study and such a large percentage of youth are sedentary (96.4%), this may explain the lack of significant associations with CSEP and MVPA. The current study adds to the evidence that sedentary behaviour and physical activity are separate concepts that need to be addressed to improve the health of youth. Research using COMPASS data has been done to examine sedentary behaviour in more detail and has suggested that interventions to decrease sedentary behaviours should be targeted to all youth and not only those who are inactive [Leatherdale & Harvey, 2015].

6.4.2 Demographic characteristics

Across all physical activity variables (MVPA, CSEP and KKD) and consistent with previous research [Leatherdale & Rynard, 2013, Belcher et al., 2010; Hobin et al., 2012; O'Loughlin et al., 1999; Iannotti & Wang, 2013], physical activity levels decreased as grade increased and were lower for females compared to males. Students identifying as "white" only achieved the MVPA and CSEP guidelines more than students who self-identified as "other", which is consistent with studies done on Canadian children and youth [O'Loughlin et al., 1999; Kukaswadia et al., 2014]. Consistent with a review study which indicated that low SES adolescents achieve less physical activity than their higher SES counterparts [Hanson & Chen, 2007], the current study found that as weekly spending money increased, so did all physical activity variables. These consistent demographic trends show that certain groups of students are at higher risk for being physically inactive. These students are females, students in higher grades, students of "other" ethnicities, and have less weekly spending money.

Therefore programs should be developed to target these groups and programs should be evaluated to ensure the target groups are being reached and their barriers to physical activity are being addressed (e.g., girls only exercise classes, mandatory physical education classes for grade 10-12 students).

6.5 Implications for research

Within physical activity research, many different outcome measures are used. These include self-report total time in MVPA minutes, MVPA recommendation, CSEP guideline, KKD, MPA minutes, or time at school in MVPA or MPA, etc. Accelerometer data can also vary based on cut points, thresholds, epoch lengths etc. The current study used three different ways to measure whether youth were physically active in order to examine physical activity compared to common guidelines as well as continuously, and demonstrated that the results were sensitive to the outcome chosen. Variable definitions are important for future research to continue to examine because what is being measured affects what can be inferred from the data. In the future COMPASS could include a subset of students who wear accelerometers to objectively measure physical activity in order to get more internally valid measures of physical activity to complement the self-report measure which has high external validity. In future studies, COMPASS could also ask students about the type of physical activity they are doing or include a larger list of activities in the description of the physical activity question to ensure that the prompts for physical activity includes exercise and activities of daily living (e.g., shovelling snow, mowing the lawn). COMPASS could also consider adding a more detailed scale for the quality rating in the Co-SEA application, in order to facilitate comparisons between schools.

There were small amounts of between school variability found within the large sample of schools and students in COMPASS using any one of the three self-reported physical activity outcome definitions. Previous research has shown that the school built environment is important for elementary and middle school students' physical activity especially when physical activity is measured objectively [Faulkner et al., 2014]. Therefore future studies on the school environment should explore objectively measured physical activity in secondary school students to determine if there is between school variability using that measure of physical activity. Another way that the environment has been shown to be important is when studying physical activity that happens at school. This allows for a more in-depth analysis of what is associated with physical activity that actually happens at school instead of more generally as was examined in the current study.

It is also important for future studies to examine the built environment for specific groups, as the impact of the school built environment may differ for specific groups. Doing a sub-sample analysis on specific groups may identify specific barriers or facilitators for physical activity. There is a potential that examining those who are least likely to achieve physical activity may show associations that are very different than those of the general student body. For example, the students in grade 9 are subject to a policy mandating physical education classes and therefore increasing their physical activity, but by studying the other grades (10, 11, 12) it would be possible to determine what the impact on physical activity schools have, aside from the physical education policy. Another interesting sub-group to examine is students who participate in sports teams as they may demonstrate very different associations with the school facilities than students who are least likely to achieve physical activity.

Future research should also consider finding ways to facilitate identifying differences between schools, for example, examining the top and bottom 25% of schools for mean physical activity. In the current study most schools had mean physical activity levels that were very similar and resulted in very low ICC values and not a lot of variability to explain by facilities or policies. There is valuable data in the COMPASS study and the school environment could be re-examined in a longitudinal study to determine if changes in the facilities or policies of the school would affect the physical activity levels of students.

Finally, other unexamined or unmeasured variables may contribute to students' physical activity levels and could be examined in future studies, such as looking at each facility individually, investigating team sports and including other environments such as neighbourhoods, homes and the social environment.

6.6 Implications for practice and policy

Overall, the low amount of between school variability and the low number of school level characteristics that were found to be significant for physical activity in this cross-sectional study would suggest that school level characteristics are not important for physical activity and that student level characteristics should be the focus for practice and policy efforts. However, the ecological model suggests that targeting individuals, the social and built environment, and policies are all important [Sallis et al., 2006]. Therefore when considering the consistent student characteristics found to be associated with less physical activity, such as being female, being in higher grades, being of "other" ethnicity, having less weekly spending money, being obese, underweight, or not reporting BMI data, it would be important to target interventions to these populations but also address the specific facilitators and barriers in the environment for these populations. For example, the social environment

may be more important to obese youth than the built environment for physical activity [Lawman & Wilson, 2014] and policies and practices need to address that environment in order to increase physical activity levels. Each group that are less likely to achieve the recommended amount of physical activity should be consulted in order to identify specific barriers and facilitators to physical activity for those groups. These groups should also be involved in creating and implementing programs at their school in order to increase buy-in and participation, in accordance with the principles of knowledge translation [CIHR, 2014]. Possible policies or practices that could be implemented include mandating physical education classes for grade 10, 11, and 12 students in order to decrease the decline seen in physical activity with increasing grade, having female only programming such as boot camp or Zumba classes to attempt to increase female participation in physical activity, providing culturally diverse sports for students of "other" ethnicities and providing intramural programs for students at no cost to increase participation of students with less weekly spending money. These potential policies and practices would need to be examined to determine feasibility and if implemented, thoroughly evaluated to determine if they are achieving their intended goal.

6.7 Study Strengths

The current study uses variable definitions for student measures that are consistent with previous research and accepted guidelines [Leatherdale & Rynard, 2013; CSEP, 2014; Health Canada, 2014] in order to facilitate comparisons in the literature. When examining the within school built environment there is not a lot of consistency in the literature so the current study explored many different variables that were novel to the field including the use of the CSEP guideline as an outcome measure, using unbiased observational data for both facilities and quality ratings as well as including an accessibility measure. These variables and data

collection methods add to the research on the secondary school built environment and physical activity in Canada. The current study is well positioned to provide baseline data for future longitudinal analysis using the COMPASS data to determine if changes to the school environment impact student physical activity levels. Finally, the data set used is a strength due to the robust nature of the data. COMPASS has a large sample size with a very low refusal rate (0.01%). Many of the survey questions used in COMPASS have been validated through various studies [Leatherdale, Laxer & Faulkner, 2014; Leatherdale & Laxer, 2013] and the physical activity questionnaire was found to be comparable to other similar self-report measures for both reliability and validity [Leatherdale, Laxer & Faulkner, 2014].

6.8 Limitations

Due to the fact that the current study was a secondary data analysis the limitations inherent in the host study need to be considered. Methodological limitations include the use of self-report data, which tends to result in overestimation of physical activity. However, the questionnaire has been determined to be reliable and valid for self-report data collection in youth [Leatherdale, Laxer & Faulkner, 2014]. The questionnaire used in COMPASS is also limited in what it captures. The prompts associated with the descriptions of "HARD" physical activity and "MODERATE" physical activity are more geared towards exercise instead of total physical activity which would encompass activities of daily living. The questionnaire does not provide information on the type of activity students are doing for physical activity, which may have provided important additional information. COMPASS is a convenience sample of schools and so it is not provincially or nationally representative, although the sample includes a large number of schools and has a very small refusal rate (0.01% refusal) leading to high external validity.

The built environment data from the Co-SEA application and policies and practices information from the school policies and practices questionnaire were limited by the person who completed them (data collector and staff member of the school, respectively). Current research is underway to examine the inter-rater reliability of the Co-SEA application. The built environment data and policies data was collected in the first year that the school took part in the study. However, for 43 schools the student and the school level data were from different years. There were minimal changes to school level data over the course of the year however, and it does not affect the findings (Appendix H).

The current study is cross sectional in design and therefore does not allow for causal inferences and so is limited in what it can report. However, COMPASS is a longitudinal study and therefore cause and effect could be examined in future studies using the current study as a baseline. There are also limitations in the created variable definitions used for the analysis. Using KKD in youth is limited, since energy expenditure is affected by age [Bryan & Katzmarzyk, 2009] and there are no MET values specifically designed for youth [Strong et al., 2005, Corder et al., 2008]. However, KKD allows for a good estimation of total physical activity, while taking into account intensity, and is used in similar studies [Leatherdale & Wong, 2008; Leatherdale et al., 2008; Leatherdale, Faulkner & Arbour-Nicitopoulos 2010].

Chapter 7: Conclusions

The current study highlights that the majority of youth are not getting enough physical activity with 49.3% achieving 60 minutes of moderate to vigorous physical activity (MVPA) daily and 31.0% meeting the Canadian Society for Exercise Physiology (CSEP) guidelines. The mean energy expenditure (KKD) value for the entire sample was 9.6 kcal/kg/day (±7.0). Additionally, where a student goes to school was not associated with their physical activity levels; demonstrated by the low between school variability (0.8% to 1.2%) and few school level characteristics were associated with students' physical activity. Students attending public schools, compared to private schools were more likely to achieve the MVPA recommendation and the accessibility score of schools was negatively associated with students achieving the CSEP guidelines. No school level characteristics were significant for KKD when taking into account student level factors. Student level factors were identified as significant for all three physical activity variables. Those who were least likely to achieve physical activity were females, grade 12 students, students with $0 weekly income, students who were not current binge drinkers and those who did not eat the recommended servings of fruits and vegetables and students who did not report their height or weight resulting in a missing body mass index. These student level variables were consistently associated with physical activity across all three variable definitions and should be addressed by targeted interventions. Due to the fact that the study did not find a lot of variability between schools for physical activity, more research is warranted to further explore the relationships identified and to explore changes in the school environment as well as other environments that are associated with physical activity.

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Appendix A: CO-SEA Rating criteria

Given verbally for baseline measures
Given in written format starting in 2014/2015 data collections

Poor:	Facilities or spaces are damaged or unkempt to the extent that they are no longer useable or fit for their purpose.
Adequate:	Facilities or spaces show some damage or missing some components, but their use is not impaired.
Good:	Facilities or spaces are clean and well maintained with no visible damage and are clearly fit for their purpose.
Unable to Assess:	Data collector cannot assess the quality of the facility due to weather (snow-cover/spring flooding) or lack of access (e.g., doors are locked)

Appendix B: COMPASS questionnaire

About You

1. What grade are you in?

- ○ Grade 9
- ○ Grade 10
- ○ Grade 11
- ○ Grade 12

2. How old are you today?

- ○ 13 years or younger
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

3. Are you female or male?

- ○ Female
- ○ Male

4. How would you describe yourself? *(Mark all that apply)*

- ○ White
- ○ Black
- ○ Asian
- ○ Aboriginal (First Nations, Métis, Inuit)
- ○ Latin American/Hispanic
- ○ Other _____

5. About how much money do you usually get each week to spend on yourself or to save?
(Remember to include all money from allowances and jobs like baby-sitting, delivering papers, etc.)

- ○ Zero
- ○ $1 to $5
- ○ $6 to $10
- ○ $11 to $20
- ○ $21 to $40
- ○ $41 to $100
- ○ More than $100
- ○ I do not know how much money I get each week

6. How do you usually travel to and from school?

To school	From school
○ By car (as a passenger)	○ By car (as a passenger)
○ By car (as a driver)	○ By car (as a driver)
○ By school bus	○ By school bus
○ By public bus	○ By public bus
○ By walking	○ By walking
○ By bicycling	○ By bicycling
○ By subway or streetcar	○ By subway or streetcar
○ Other_____	○ Other_____

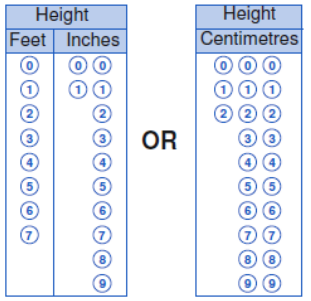
7. How tall are you without your shoes on? (Please write your height in feet and inches **OR** in centimetres, and then fill in the appropriate numbers for your height.)

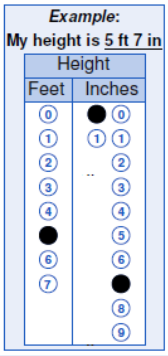
○ **I do not know how tall I am**

"My height is ____feet ____ inches"

OR

"My height is _____centimetres"





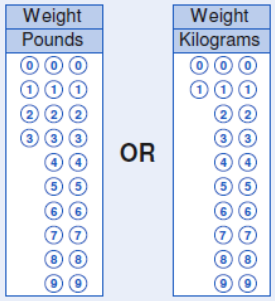
8. How much do you weigh without your shoes on? (Please write your weight in pounds **OR** in kilograms, and then fill in the appropriate numbers for your weight.)

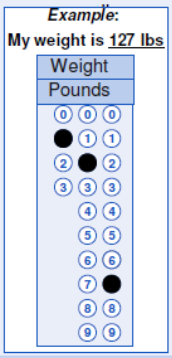
○ **I do not know how much I weigh**

"My weight is _____pounds"

OR

"My weight is _____kilograms"





9. How much time per day do you *usually* spend doing the following activities?

For example: If you spend about 3 hours watching TV each day, you will need to fill in the 3 hour circle, and the 0 minute circle as shown below:

	Hours	Minutes
a) Watching/streaming TV shows or movies	0 1 2 3 4 5 6 7 8 9	0 15 30 45
b) Playing video/computer games	0 1 2 3 4 5 6 7 8 9	0 15 30 45
c) Doing homework	0 1 2 3 4 5 6 7 8 9	0 15 30 45
d) Talking on the phone	0 1 2 3 4 5 6 7 8 9	0 15 30 45
e) Surfing the internet	0 1 2 3 4 5 6 7 8 9	0 15 30 45
f) Texting, messaging, emailing **(note: 50 texts = 30 minutes)**	0 1 2 3 4 5 6 7 8 9	0 15 30 45
g) Sleeping	0 1 2 3 4 5 6 7 8 9	0 15 30 45

Physical Activity

HARD physical activities include jogging, team sports, fast dancing, jump-rope and any other physical activities that increase your heart rate and make you breathe hard and sweat.

MODERATE physical activities include lower intensity activities such as walking, biking to school, and recreational swimming.

10. Mark how many minutes of HARD physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time.

	Hours					Minutes				
Monday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Tuesday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Wednesday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Thursday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Friday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Saturday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Sunday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	

For example: If you did 45 minutes of hard physical activity on Monday, you will need to fill in the 0 hour circle and the 45 minute circle, as shown below:

	Hours					Minutes				
Monday	● 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	● 45	

11. Mark how many minutes of MODERATE physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities.

	Hours					Minutes				
Monday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Tuesday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Wednesday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Thursday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Friday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Saturday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	
Sunday	○ 0	○ 1	○ 2	○ 3	○ 4	○ 0	○ 15	○ 30	○ 45	

For example: If you did 1 hour and 30 minutes of moderate physical activity on Monday, you will need to fill in the 1 hour circle and the 30 minute circle, as shown below:

	Hours					Minutes				
Monday	○ 0	● 1	○ 2	○ 3	○ 4	○ 0	○ 15	● 30	○ 45	

12. Were the last 7 days a typical week in terms of the amount of physical activity that you usually do?

- ○ Yes
- ○ No, I was *more* active in the last 7 days
- ○ No, I was *less* active in the last 7 days

13. Your closest friends are the friends you like to spend the most time with. How many of your closest friends are physically active?

- ○ None
- ○ 1 friend
- ○ 2 friends
- ○ 3 friends
- ○ 4 friends
- ○ 5 or more friends

14. Are you taking a physical education class at school this year?

- ○ **Yes**, I am taking one **this term**
- ○ **Yes,** I will be taking one or have taken one this school year, **but not this term**.
- ○ **No**, I am not taking a physical education class at school this year

15. Do you participate in before-school, noon hour, or after-school physical activities organized by your school? *(e.g., intramurals, non-competitive clubs)*

- ○ Yes
- ○ No
- ○ None offered at my school

16. Do you participate in competitive school sports teams that compete against other schools? *(e.g., junior varsity or varsity sports)*

- ○ Yes
- ○ No
- ○ None offered at my school

17. Do you participate in league or team sports outside of school?

- ○ Yes
- ○ No
- ○ There are none available where I live

18. On how many days in the last 7 days did you do exercises to strengthen or tone your muscles? *(e.g., push-ups, sit-ups, or weight-training)*

- ○ 0 days
- ○ 1 day
- ○ 2 days
- ○ 3 days
- ○ 4 days
- ○ 5 days
- ○ 6 days
- ○ 7 days

19. How do you describe your weight?

- ○ Very underweight
- ○ Slightly underweight
- ○ About the right weight
- ○ Slightly overweight
- ○ Very overweight

20. Which of the following are you trying to do about your weight?

- ○ **Lose** weight
- ○ **Gain** weight
- ○ **Stay** the same weight
- ○ I am **not trying to do anything** about my weight

21. How much do your parents, step-parents, or guardians encourage you to be physically active?

- ○ Strongly encourage
- ○ Encourage
- ○ Do not encourage or discourage
- ○ Discourage
- ○ Strongly discourage

22. How much do your parents, step-parents, or guardians support you in being physically active? *(e.g., driving you to team games, buying you sporting equipment)*

- ○ Very supportive
- ○ Supportive
- ○ Unsupportive
- ○ Very unsupportive

Healthy Eating

23. If you do not eat breakfast every day, why do you skip breakfast? *(Mark all that apply)*

- ○ I eat breakfast every day
- ○ I don't have time for breakfast
- ○ The bus comes too early
- ○ I sleep in
- ○ I'm not hungry in the morning
- ○ I feel sick when I eat breakfast
- ○ I'm trying to lose weight
- ○ There is nothing to eat at home
- ○ Other _____

24. In a *usual* school week *(Monday to Friday)*, on how many days do you do the following?

	None	1 day	2 days	3 days	4 days	5 days
a) Eat breakfast	○	○	○	○	○	○
b) Eat breakfast provided to you **as part of a school program**	○	○	○	○	○	○
c) Eat lunch at school - lunch packed and brought from home	○	○	○	○	○	○
d) Eat lunch at school - lunch purchased in the cafeteria	○	○	○	○	○	○
e) Eat lunch purchased at a fast food place or restaurant	○	○	○	○	○	○
f) Eat snacks purchased from a vending machine **in your school**	○	○	○	○	○	○
g) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen **off school property**	○	○	○	○	○	○
h) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) Do not include diet/sugar-free drinks	○	○	○	○	○	○
i) Drink high-energy drinks (Red Bull, Monster, Rock Star, etc.)	○	○	○	○	○	○
j) Drink coffee or tea **with sugar** (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	○	○	○	○	○	○
k) Drink coffee or tea **without sugar**	○	○	○	○	○	○

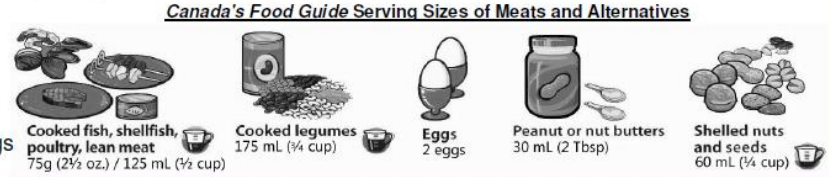
25. On a *usual* weekend *(Saturday and Sunday)*, on how many days do you do the following?

	None	1 day	2 days
a) Eat breakfast	○	○	○
b) Eat lunch	○	○	○
c) Eat foods purchased at a fast food place or restaurant	○	○	○
d) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen	○	○	○
e) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) Do not include diet/sugar-free drinks	○	○	○
f) Drink high energy drinks (Red Bull, Monster, Rock Star, etc.)	○	○	○
g) Drink coffee or tea **with sugar** (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	○	○	○
h) Drink coffee or tea **without sugar**	○	○	○

26. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of meats and alternatives did you have? *One 'Food Guide' serving of meat and alternatives includes cooked fish, chicken, beef, pork, or game meat, eggs, nuts or seeds, peanut butter or nut butters, legumes (beans), and tofu.*

- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 or more servings

***Canada's Food Guide* Serving Sizes of Meats and Alternatives**



27. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of vegetables and fruits did you have? *One 'Food Guide' serving of vegetables and fruit includes pieces of fresh vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice.*

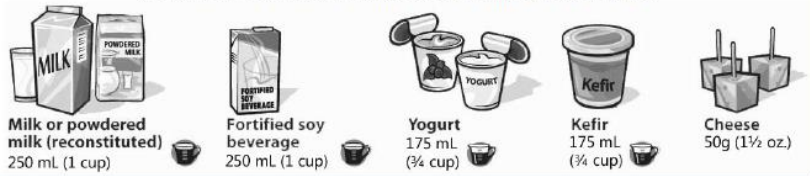
- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 servings
- ○ 6 servings
- ○ 7 servings
- ○ 8 servings
- ○ 9 or more servings

***Canada's Food Guide* Serving Sizes of Vegetables and Fruits**

28. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of milk and alternatives did you have? *One 'Food Guide' serving of milk or milk alternatives includes milk, fortified soy beverage, reconstituted powdered milk, canned (evaporated) milk, yogurt or kefir (another type of cultured milk product), and cheese.*

- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 servings
- ○ 6 or more servings

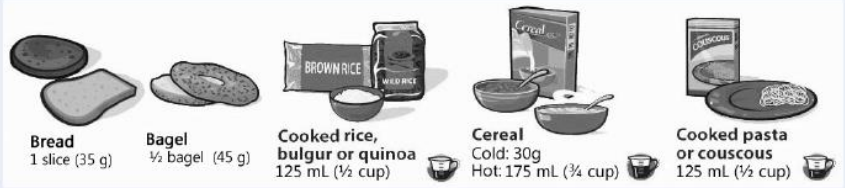
***Canada's Food Guide* Serving Sizes of Milk and Alternatives**



29. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of grain products did you have? *One 'Food Guide' serving of grain products includes bread, bagels, flatbread such as tortilla, pita, cooked rice or pasta, and cold cereal.*

- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 servings
- ○ 6 servings
- ○ 7 servings
- ○ 8 servings
- ○ 9 or more servings

***Canada's Food Guide* Serving Sizes of Grain Products**



Your Experience with Smoking

30. Have you ever tried cigarette smoking, even just a few puffs?

- ○ Yes
- ○ No

31. How old were you when you first tried smoking cigarettes, even just a few puffs?

- ○ I have never done this
- ○ I do not know

- ○ 8 years or younger
- ○ 9 years
- ○ 10 years
- ○ 11 years
- ○ 12 years
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

32. Do you think in the future you might try smoking cigarettes?

- ○ Definitely yes
- ○ Probably yes
- ○ Probably not
- ○ Definitely not

33. If one of your best friends was to offer you a cigarette, would you smoke it?

- ○ Definitely yes
- ○ Probably yes
- ○ Probably not
- ○ Definitely not

34. At any time during the next year do you think you will smoke a cigarette?

- ○ Definitely yes
- ○ Probably yes
- ○ Probably not
- ○ Definitely not

35. Do you think it would be difficult or easy for you to get cigarettes if you wanted to smoke?

- ○ Difficult
- ○ Easy
- ○ I do not know

36. Have you ever smoked a whole cigarette?

- ○ Yes
- ○ No

37. Have you ever smoked 100 or more whole cigarettes in your life?

- ○ Yes
- ○ No

38. Have you ever smoked every day for at least 7 days in a row?

- ○ Yes
- ○ No

39. On how many of the last 30 days did you smoke one or more cigarettes?

- ○ None
- ○ 1 day
- ○ 2 to 3 days
- ○ 4 to 5 days
- ○ 6 to 10 days
- ○ 11 to 20 days
- ○ 21 to 29 days
- ○ 30 days *(every day)*

40. Thinking back over the last 30 days, on the days that you smoked, how many cigarettes did you usually smoke each day?

- ○ None
- ○ A few puffs to one whole cigarette
- ○ 2 to 3 cigarettes
- ○ 4 to 5 cigarettes
- ○ 6 to 10 cigarettes
- ○ 11 to 20 cigarettes
- ○ 21 to 29 cigarettes
- ○ 30 or more cigarettes

41. Your closest friends are the friends you like to spend the most time with. How many of your closest friends smoke cigarettes?

- ○ None
- ○ 1 friend
- ○ 2 friends
- ○ 3 friends
- ○ 4 friends
- ○ 5 or more friends

42. Have you ever tried to quit smoking cigarettes?

- ○ I have never smoked
- ○ I have only smoked a few times
- ○ I have never tried to quit
- ○ I have tried to quit once
- ○ I have tried to quit 2 or 3 times
- ○ I have tried to quit 4 or 5 times
- ○ I have tried to quit 6 or more times

43. In the last 30 days, did you use any of the following? *(Mark all that apply)*

- ○ Pipe tobacco
- ○ Cigarillos or little cigars (*plain or flavoured*)
- ○ Cigars (not including cigarillos or little cigars, *plain or flavoured*)
- ○ Roll-your-own cigarettes (tobacco only)
- ○ Loose tobacco mixed with marijuana
- ○ Bidis (little flavoured cigarettes that are hand-rolled in leaves and tied at the ends with string)
- ○ Smokeless tobacco (chewing tobacco, pinch, snuff, or snus)
- ○ Nicotine patches, nicotine gum, nicotine lozenges, or nicotine inhalers
- ○ Hookah (water-pipe) to smoke tobacco
- ○ Hookah (water-pipe) to smoke herbal sheesha/shisha
- ○ Blunt wraps (a sheet or tube made of tobacco used to roll cigarette tobacco)
- ○ I have not used any of these things in the last 30 days

Alcohol and Marijuana Use

*Please remember that we will keep your answers **completely confidential**.*

A DRINK means: 1 regular sized bottle, can, or draft of beer; 1 glass of wine; 1 bottle of cooler; 1 shot of liquor (rum, whiskey, etc); or 1 mixed drink (1 shot of liquor with pop, juice, energy drink).

44. In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?

- ○ I have never drunk alcohol
- ○ I did not drink alcohol in the last 12 months
- ○ I have only had a sip of alcohol

- ○ Less than once a month
- ○ Once a month
- ○ 2 or 3 times a month
- ○ Once a week
- ○ 2 or 3 times a week
- ○ 4 to 6 times a week
- ○ Every day

45. How old were you when you first had a drink of alcohol that was more than just a sip?

- ○ I have never drunk alcohol
- ○ I have only had a sip of alcohol
- ○ I do not know

- ○ 8 years or younger
- ○ 9 years
- ○ 10 years
- ○ 11 years
- ○ 12 years
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

46. In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?

- ○ I have never done this
- ○ I did not have 5 or more drinks on one occasion in the last 12 months
- ○ Less than once a month
- ○ Once a month
- ○ 2 to 3 times a month
- ○ Once a week
- ○ 2 to 5 times a week
- ○ Daily or almost daily

47. In the last 12 months, have you had alcohol mixed or pre-mixed with an energy drink such as Red Bull, Rock Star, Monster, or another brand?

- ○ I have never done this
- ○ I did not do this in the last 12 months
- ○ Yes
- ○ I do not know

48. In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)

- ○ I have never used marijuana
- ○ I have used marijuana but not in the last 12 months
- ○ Less than once a month
- ○ Once a month
- ○ 2 or 3 times a month
- ○ Once a week
- ○ 2 or 3 times a week
- ○ 4 to 6 times a week
- ○ Every day

49. How old were you when you first used marijuana or cannabis?

- ○ I have never used marijuana
- ○ I do not know

- ○ 8 years or younger
- ○ 9 years
- ○ 10 years
- ○ 11 years
- ○ 12 years
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

50. Do you think it would be difficult or easy for you to get marijuana if you wanted some?

- ○ Difficult
- ○ Easy
- ○ I do not know

Your School and You

51. How strongly do you agree or disagree with each of the following?

	Strongly Agree	Agree	Disagree	Strongly Disagree
a) I feel close to people at my school.	○	○	○	○
b) I feel I am part of my school.	○	○	○	○
c) I am happy to be at my school.	○	○	○	○
d) I feel the teachers at my school treat me fairly.	○	○	○	○
e) I feel safe in my school.	○	○	○	○
f) Getting good grades is important to me.	○	○	○	○

52. In the last 30 days, in what ways were you bullied by other students? *(Mark all that apply)*

- ○ I have not been bullied in the last 30 days
- ○ Physical attacks (e.g., getting beaten up, pushed, or kicked)
- ○ Verbal attacks (e.g., getting teased, threatened, or having rumours spread about you)
- ○ Cyber-attacks (e.g., being sent mean text messages or having rumours spread about you on the internet)
- ○ Had someone steal from you or damage your things

53. In the last 30 days, how often have you been bullied by other students?

- ○ I have not been bullied by other students in the last 30 days
- ○ Less than once a week
- ○ About once a week
- ○ 2 or 3 times a week
- ○ Daily or almost daily

54. In the last 30 days, in what ways did you bully other students? *(Mark all that apply)*

- ○ I did not bully other students in the last 30 days
- ○ Physical attacks (e.g., beat up, pushed, or kicked them)
- ○ Verbal attacks (e.g., teased, threatened, or spread rumours about them)
- ○ Cyber-attacks (e.g., sent mean text messages or spread rumours about them on the internet)
- ○ Stole from them or damaged their things

55. In the last 30 days, how often have you taken part in bullying other students?

- ○ I did not bully other students in the last 30 days
- ○ Less than once a week
- ○ About once a week
- ○ 2 or 3 times a week
- ○ Daily or almost daily

56. How supportive is your school of the following?

	Very supportive	Supportive	Unsupportive	Very unsupportive
a) Making sure there are opportunities for students to be physically active	○	○	○	○
b) Making sure students have access to healthy foods and drinks	○	○	○	○
c) Making sure no one is bullied at school	○	○	○	○
d) Giving students the support they need to resist or quit tobacco	○	○	○	○
e) Giving students the support they need to resist or quit drugs and/or alcohol	○	○	○	○

57. What academic level was your current or most recent Math course?

- ○ Applied
- ○ Academic
- ○ Other _____

58. In your current or most recent Math course, what is your approximate overall mark?
(Think about last year if you have not taken math yet this year)

- ○ 90% - 100%
- ○ 80% - 89%
- ○ 70% - 79%
- ○ 60% - 69%
- ○ 55% - 59%
- ○ 50% - 54%
- ○ Less than 50%

59. In your current or most recent English course, what is your approximate overall mark?
(Think about last year if you have not taken English yet this year)

- ○ 90% - 100%
- ○ 80% - 89%
- ○ 70% - 79%
- ○ 60% - 69%
- ○ 55% - 59%
- ○ 50% - 54%
- ○ Less than 50%

60. What is the highest level of education you would like to get?

- ○ Some high school or less
- ○ High school diploma or graduation equivalency
- ○ College/trade/vocational certificate
- ○ University Bachelor's degree
- ○ University Master's / PhD / law school / medical school / teachers' college degree
- ○ I don't know

61. What is the highest level of education you think you will get?

- ○ Some high school or less
- ○ High school diploma or graduation equivalency
- ○ College/trade/vocational certificate
- ○ University Bachelor's degree
- ○ University Master's / PhD / law school / medical school / teachers' college degree
- ○ I don't know

62. In the last 4 weeks, how many days of school did you miss because of your health?

- ○ 0 days
- ○ 1 or 2 days
- ○ 3 to 5 days
- ○ 6 to 10 days
- ○ 11 or more days

63. In the last 4 weeks, how many classes did you skip when you were not supposed to?

- ○ 0 classes
- ○ 1 or 2 classes
- ○ 3 to 5 classes
- ○ 6 to 10 classes
- ○ 11 to 20 classes
- ○ More than 20 classes

64. How often do you go to class without your homework complete?

- ○ Never
- ○ Seldom
- ○ Often
- ○ Usually

Appendix C: Descriptive statistics for RT and VPA - exploratory analysis

Table 10: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by RT

		Not achieving RT >= 3 days per week (n=16350) % (n)	Achieving RT >= 3 days per week (n=18947) % (n)	Total (n=35297) % (n)	Chi Square df
Gender	Female	54.6 (8929)	46.1 (8743)	50.1 (17672)	χ^2=251.7* df=1
	Male	45.4 (7421)	53.9 (10204)	49.9 (17625)	
Meeting recommendation of 60 minutes MVPA daily?	No	62.2 (10176)	40.7 (7714)	50.7 (17890)	χ^2=1626.8* df=1
	Yes	37.8 (6174)	59.3 (11233)	49.3 (17407)	
VPA >= 3 days per week?	No	40.0 (6536)	7.0 (1328)	22.3 (7864)	χ^2=5508.4* df=1
	Yes	60.0 (9814)	93.0 (17619)	77.7 (27433)	
Grade	9	23.1 (3780)	27.2 (5159)	25.3 (8939)	χ^2=122* df=3
	10	25.5 (4174)	26.4 (4997)	26.0 (9171)	
	11	25.7 (4199)	24.7 (4671)	25.1 (8870)	
	12	25.7 (4197)	21.7 (4120)	23.6 (8317)	
Ethnicity	White only	75.9 (12405)	74.7 (14152)	75.2 (26557)	χ^2=6.5** df=1
	Other	24.1 (3945)	25.3 (4795)	24.8 (8740)	
Weekly spending money	$0	21.0 (3432)	15.5 (2932)	18.0 (6364)	χ^2=217.7* df=3
	$1-20	33.3 (5439)	32.6 (6178)	32.9 (11617)	
	$21-99	28.7 (4688)	32.4 (6131)	30.7 (10819)	
	>$100	17.1 (2791)	19.6 (3706)	18.4 (6497)	
Current binge drinker	No	79.5 (12994)	71.3 (13513)	75.1 (26507)	χ^2=312* df=1
	Yes	20.5 (3356)	28.7 (5434)	24.9 (8790)	
Current marijuana user	No	85.1 (13911)	81.9 (15510)	83.4 (29421)	χ^2=65.7* df=1
	Yes	14.9 (2439)	18.1 (3437)	16.7 (5876)	
Current smoker	No	93.5 (15287)	94.0 (17806)	93.8 (33093)	χ^2=3.4 df=1
	Yes	6.5 (1063)	6.0 (1141)	6.2 (2204)	
Eating recommended fruits and vegetables	No	96.7 (15817)	92.9 (17596)	94.7 (33413)	χ^2=260.2* df=1
	Yes	3.3 (533)	7.1 (1351)	5.3 (1884)	
BMI	Missing	22.9 (3738)	15.6 (2952)	19.0 (6690)	χ^2=406.6* df=4
	Underweight	1.9 (318)	1.2 (219)	1.5 (537)	
	Normal	54.9 (8968)	61.7 (11695)	58.5 (20663)	
	Overweight	13.2 (2158)	15.6 (2955)	14.5 (5113)	
	Obese	7.1 (1168)	5.9 (1126)	6.5 (2294)	
Sedentary behaviour	No	3.4 (555)	3.8 (715)	3.6 (1270)	χ^2=3.6 df=1
	Yes	96.6 (15795)	96.2 (18232)	96.4 (34027)	
		mean (sd)	mean (sd)	mean (sd)	T-Test df
KKD		7.0 (5.8)	11.9 (7.0)	9.6 (7.0)	T = 72.2* df= 35241

Notes: *:p-value of **<0.001** ** p-value of **<0.05**
Satterthwaite t-test, unequal variance
MVPA= moderate to vigorous physical activity, RT= resistance training, VPA= vigorous physical activity, CSEP= MVPA+RT+VPA
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days

Table 11: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by VPA

		Not achieving VPA >= 3 days per week (n=7864) % (n)	Achieving VPA >= 3 days per week (n=27433) % (n)	Total (n=35297) % (n)	Chi Square df
Gender	Female	59.8 (4701)	47.3 (12971)	50.1 (17672)	χ^2=381.8* df=1
	Male	40.2 (3163)	52.7 (14462)	49.9 (17625)	
Meeting recommendation of 60 minutes MVPA daily?	No	81.6 (6418)	41.8 (11472)	50.7 (17890)	χ^2=3872.2* df=1
	Yes	18.4 (1446)	58.2 (15961)	49.3 (17407)	
RT >= 3 days per week?	No	83.1 (6536)	35.8 (9814)	46.3 (16350)	χ^2=5508.4* df=1
	Yes	16.9 (1328)	64.2 (17619)	53.7 (18947)	
Grade	9	17.4 (1366)	27.6 (7573)	25.3 (8939)	χ^2=484.4* df=3
	10	25.0 (1963)	26.3 (7208)	26.0 (9171)	
	11	27.1 (2129)	24.6 (6741)	25.1 (8870)	
	12	30.6 (2406)	21.6 (5911)	23.6 (8317)	
Ethnicity	White only	72.9 (5732)	75.9 (20825)	75.2 (26557)	χ^2=30.0* df=1
	Other	27.1 9 (2132)	24.1 (6608)	24.8 (8740)	
Weekly spending money	$0	24.1 (1894)	16.3 (4470)	18.0 (6364)	χ^2=261.2* df=3
	$1-20	30.9 (2430)	33.5 (9187)	32.9 (11617)	
	$21-99	27.1 (2131)	31.7 (8688)	30.7 (10819)	
	>$100	17.9 (1409)	18.6 (5088)	18.4 (6497)	
Current binge drinker	No	79.9 (6284)	73.7 (20223)	75.1 (26507)	χ^2=125.3* df=1
	Yes	20.1 (1580)	26.3 (7210)	24.9 (8790)	
Current marijuana user	No	83.5 (6569)	83.3 (22852)	83.4 (29421)	χ^2=0.2 df=1
	Yes	16.5 (1295)	16.7 (4581)	16.7 (5876)	
Current smoker	No	91.8 (7222)	94.3 (25871)	93.8 (33093)	χ^2=63.7* df=1
	Yes	8.2 (642)	5.7 (1562)	6.2 (2204)	
Eating recommended fruits and vegetables	No	96.9 (7618)	94.0 (25795)	94.7 (33413)	χ^2=97.8* df=1
	Yes	3.1 (246)	6.0 (1638)	5.3 (1884)	
BMI	Missing	25.1 (1971)	17.2 (4719)	19.0 (6690)	χ^2=319.2* df=4
	Underweight	2.2 (169)	1.3 (368)	1.5 (537)	
	Normal	52.6 (4133)	60.3 (16530)	58.5 (20663)	
	Overweight	12.8 (1009)	15.0 (4104)	14.5 (5113)	
	Obese	7.4 (582)	6.2 (1712)	6.5 (2294)	
Sedentary behaviour	No	3.3 (257)	3.7 (1013)	3.6 (1270)	χ^2=3.2 df=1
	Yes	96.7 (7607)	96.3 (26420)	96.4 (34027)	
		mean (sd)	mean (sd)	mean (sd)	T-Test df
KKD		3.1 (2.8)	11.5 (6.7)	9.6 (7.0)	T = 165.1* df= 31057

Notes: *:p-value of **<0.001**
Satterthwaite t-test, unequal variance
MVPA= moderate to vigorous physical activity, RT= resistance training, VPA= vigorous physical activity,
CSEP= MVPA+RT+VPA
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days

Appendix D: KKD - exploratory analysis

When students who reported a KKD of 0 were removed:

There were 34406 observations included (instead of 35297).

The new prevalence for each variable is:

- KKD: 9.9 kcal/kg/day
- MVPA: 50.6%
- CSEP: 31.8%

ICC's are the same, except:

- KKD ICC= 0.011 (instead of 0.012).

The univariate and multivariate models showed no differences in significance, except:

- Facility condition for MVPA in univariate is now not significant (p=0.0576)

The final models showed no differences in significance, except:

- KKD: smoking becomes significant. Est=0.75, <0.001.
- CSEP: ethnicity and smoking are no longer significant
- MVPA: smoking and marijuana are now significant at <0.05

Table 12: Number of KKD=0 students who are current smokers

Current Smoker	KKD=0
0 – Non-smoker	735
1 - Smoker	156
Total	891

Appendix E: School level characteristics

School level univariate analysis

School level variability accounted for 0.8% to 1.2% of variation in student's MVPA, CSEP or KKD (Table 8). In order to explore the variability each school level characteristic was examined individually (Table 13).

Table 13: Univariate analysis of school level factors for the Year 2 COMPASS schools

Variable		MVPA		CSEP		KKD	
		OR (95% CI)	P-value	OR (95% CI)	P-value	Est (se)	P-value
School enrolment	<500 students	**1.18 (1.02, 1.36)**	**0.02**	0.98 (0.86, 1.12)	0.76	**0.72 (0.27)**	**<0.01**
	501-1000 students	**1.14 (1.02, 1.28)**	**0.03**	1.01 (0.91, 1.13)	0.81	**0.55 (0.22)**	**0.01**
	>1001 students	1.00	.	1.00	.	REF	.
School location	Rural	1.32 (1.00, 1.75)	>0.05	0.97 (0.74, 1.28)	0.83	0.51 (0.54)	0.34
	Small Urban	**1.14 (1.03, 1.25)**	**0.01**	0.94 (0.85, 1.03)	0.17	**0.44 (0.19)**	**0.02**
	Medium Urban	**1.24 (1.09, 1.41)**	**<0.01**	0.98 (0.86, 1.11)	0.73	**0.67 (0.26)**	**<0.01**
	Large Urban	1.00	.	1.00	.	REF	.
School type	Private	**0.76 (0.64, 0.91)**	**<0.01**	0.88 (0.74, 1.04)	0.13	-0.60 (0.35)	0.09
	Public	1.00	.	1.00	.	REF	.
Number of Indoor facilities	1 unit change	0.98 (0.94, 1.02)	0.36	0.99 (0.96, 1.03)	0.71	-0.04 (0.07)	0.61
Number of Outdoor facilities	1 unit change	1.02 (0.99, 1.05)	0.21	1.01 (0.98, 1.03)	0.87	0.05 (0.05)	0.33
Number of facilities	1 unit change	1.00 (0.99, 1.02)	0.68	1.00 (0.98, 1.02)	0.94	0.01 (0.04)	0.68
Average condition of facilities [a]	1 unit change	**0.88 (0.78, 1.00)**	**0.047**	0.93 (0.83, 1.04)	0.21	-0.26 (0.24)	0.28
Facility access during non-instructional time [b]	1 unit change	1.01 (0.95, 1.07)	0.82	0.95 (0.91, 1.01)	0.08	-0.001 (0.12)	1.00
Accessibility score [c]	1 unit change	0.99 (0.97, 1.01)	0.40	**0.97 (0.95, 0.99)**	**0.001**	-0.03 (0.04)	0.41

Based on data from 35297 students at 89 secondary schools as part of the Year 2 COMPASS study
a= Facilities that were not rated were not included in the average
b= Access to indoor facilities, outdoor facilities and equipment were added together to give a maximum of 3. Missing data was taken as a "no" unless all were missing (only looks at 88 schools, 1 missing).
c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing.
MVPA= achieve 60 min every day of moderate to vigorous physical activity (Yes=1 or No=0)
CSEP= achieve MVPA, as well as VPA and RT 3 days per week (Yes=1 or No=0)
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days – one unit changes represented.

Univariate school- level characteristics associated with MVPA

As shown in Table 13, there were variables identified as being associated with MVPA during the univariate analysis. Relative to students attending a school with over 1,001 students enrolled, students attending a school with 501-1,000 students (OR 1.14, 95%CI 1.02 to 1.28) and less than 500 students (OR 1.18, 95%CI 1.02 to 1.36) were more likely to achieve MVPA daily. Relative to students attending a school in a large urban area, students at schools in medium urban areas (OR 1.24, 95%CI 1.09 to 1.41) and small urban areas (OR 1.14, 95%CI 1.03 to 1.25) were more likely to achieve MVPA. Students attending a private school were less likely to achieve MVPA than students attending a public school (OR 0.76, 95%CI 0.64 to 0.91). Finally, students attending schools with higher average condition of facilities were less likely to achieve MVPA (OR 0.88, 95%CI 0.78 to 0.998). The remaining school level variables were not significant.

Univariate school- level characteristics associated with CSEP

As shown in Table 13, students attending a school with a higher accessibility score were less likely to achieve the CSEP guidelines (OR 0.97, 95%CI 0.95 to 0.99). The remaining school level variables were not significant.

Univariate school- level characteristics associated with KKD

As shown in Table 13, relative to students attending a school with over 1,001 students enrolled, students attending a school with 501-1,000 students (β= 0.55 se= 0.22 p=0.01) and less than 500 students (β=0.72 se= 0.27 p<.01) had higher KKD values. Relative to students attending a school in a large urban area, students at schools in medium urban areas (β= 0.67 se= 0.26 p<.01) and small urban areas (β= 0.44 se= 0.19 p<.02) had higher KKD values. The remaining school level variables were not significant.

School level multivariate analysis

Multiple school level characteristics were identified as significant during the univariate analysis for MVPA and KKD, so a multivariate analysis was also performed. Only the accessibility score was significant for CSEP so it was not necessary to do a multivariate analysis.

Table 14: Multivariate analysis of school level factors for the Year 2 COMPASS schools

Variable		MVPA		KKD	
		OR (95% CI)	P-value	Est (se)	P-value
Average condition of facilities [a]	1 unit change	0.92 (0.82, 1.04)	0.20	N/A	N/A
School enrolment	<500 students	1.13 (0.96, 1.32)	0.14	0.57 (0.31)	0.06
	501-1000 students	1.10 (0.98, 1.24)	0.10	0.39 (0.24)	0.10
	>1001 students	1.00	.	REF	.
School location	Rural	1.15 (0.85, 1.55)	0.38	0.17 (0.58)	0.76
	Small Urban	1.04 (0.92, 1.16)	0.54	0.26 (0.21)	0.22
	Medium Urban	1.14 (1.00, 1.31)	>0.05	0.53 (0.27)	**<0.05**
	Large Urban	1.00	.	REF	.
School type	Private	**0.81 (0.67, 0.98)**	**0.03**	N/A	N/A
	Public	1.00	.	N/A	N/A

Based on data from 35297 students at 89 secondary schools as part of the Year 2 COMPASS study
a= Facilities that were not rated were not included in the average
MVPA= achieve 60 min every day of moderate to vigorous physical activity (Yes=1 or No=0)
KKD= [(hours of VPA*6METS) + (hours of MPA*3METS)]/7 days – one unit changes represented.

Multivariate school- level characteristics associated with MVPA

Table 14 presents the odds ratios for the school level characteristics associated with MVPA. When controlling for significant school level characteristics youth who attended a private school were less likely to achieve the MVPA recommendation than those who attended a public school (OR 0.81, 95% CI 0.67 to 0.98).

Multivariate school - level characteristics associated with KKD

Table 14 presents the odds ratios for the school level characteristics associated with KKD. When controlling for significant school level characteristics youth who attended a medium urban school were more likely to achieve the CSEP guidelines than those who attended a large urban school (Est. 0.53, se 0.27, p-value 0.048).

Inter-correlations for school level characteristics

As shown in Table 15, some school level characteristics are correlated. As expected measures that involve the same data were strongly correlated. Total number of facilities is strongly correlated with indoor and outdoor facilities, as well the accessibility score is strongly associated with the facility access during non-instructional time.

Some interesting correlations to note are that the number of outdoor facilities is moderately correlated with the number of indoor facilities, school enrolment is negatively moderately correlated with access to facilities during non-instructional time, and school location is moderately correlated with school enrolment. School type differences are moderately negatively correlated to the total number of facilities and the number of indoor facilities. While other correlations exist they are under 0.4 and are considered weak.

The presence of correlations did not directly impact the analysis of the results because each school level characteristic was examined individually in a univariate analysis. The correlations would have been important to consider in the analysis and interpretation if strongly correlated characteristics were found to be significant, however this was not the case.

Table 15: Pearson Correlation Coefficients of variables

	Total number of facilities	Number of indoor facilities	Number of outdoor facilities	Average condition of facilities [a]	Accessib-ility score [c]	Facility access during non-instructio-nal time [b]	School enrolment	School location
Total number of facilities								
Number of indoor facilities	0.77*							
Number of outdoor facilities	0.91*	0.43*						
Average condition of facilities [a]	-0.25*	0.02*	-0.38*					
Accessibility score [c]	0.00	0.01	-0.01	0.06*				
Facility access during non-instructional time [b]	0.02*	0.11*	-0.05*	-0.10*	0.65*			
School enrolment	0.09*	-0.01	0.14*	0.15*	-0.23*	-0.46*		
School location	0.02*	0.08*	-0.02*	0.24*	-0.17*	-0.34*	0.45*	
School type	-0.42*	-0.52*	-0.25*	-0.16*	-0.06*	-0.21*	0.08*	-0.26*

Based on data from 89 secondary schools

*p<0.001

a= Facilities that were not rated were not included in the average

b= Access to indoor facilities, outdoor facilities and equipment were added together to give a maximum of 3 (only looks at 88 schools due to missing data). Missing data was counted as a "no" unless all were missing.

c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing.

Appendix F: Sports teams and meeting guidelines - exploratory analysis

Table 16: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study for sports team participation and MVPA & CSEP guidelines

		Meeting MVPA	Not meeting MVPA	Meeting CSEP	Not meeting CSEP	Total
Physical activities organized by the school	Yes	56.6% (7447)	43.4% (5707)	40.4% (5310)	59.6% (7844)	37.3% (13154)
	No	45.0% (9960)	55.0% (12183)	25.5% (5637)	74.5% (16506)	62.7% (22143)
Competitive school sports teams (Varsity Sports)	Yes	57.5% (8424)	42.5% (6229)	41.9% (6138)	58.1% (8515)	41.5% (14653)
	No	43.5% (8983)	56.5% (11661)	23.3% (4809)	76.7% (15835)	58.5% (20644)
League or team sports outside of school	Yes	57.3% (10133)	42.7% (7555)	40.5% (7159)	59.5% (10529)	50.1% (17688)
	No	41.3% (7274)	58.7% (10335)	21.5% (3788)	78.5% (13821)	49.9% (17609)
Total		17407	17890	10947	24350	35297
Based on data from 35297 students at 89 secondary schools as part of the Year 2 COMPASS study Yes= self-reported: yes No= self-reported: no, not available and missing						

The majority of students did not participate in physical activities organized by the school or competitive school sports teams (varsity sports), however half of students participated in a league or team sports outside of school.
Students who participated in team sports were more likely to achieve both the MVPA and CSEP guideline.

Appendix G: BMI descriptive statistics - exploratory analysis

Table 17: Descriptive statistics for the grade 9 to 12 students in the Year 2 (2013-2014) sample of the COMPASS study by BMI

	Missing	Underweight	Normal	Overweight	Obese	Total
Meeting recommendation of 60 minutes MVPA daily? % (n)	45.8% (3062)	47.1% (253)	49.8% (10280)	51.8% (2646)	50.8% (1166)	49.3% (17407)
Achieving RT >= 3 days per week % (n)	44.1% (2952)	40.8% (219)	56.6% (11695)	57.8% (2955)	49.1% (1126)	53.7% (18947)
Achieving VPA >= 3 days per week % (n)	70.5% (4719)	68.5% (368)	80.0% (16530)	80.3% (4104)	74.6% (1712)	77.7% (27433)
Meeting CSEP guidelines % (n)	24.8% (1656)	24.4% (131)	32.6% (6729)	34.9% (1784)	28.2% (647)	31.0% (10947)
KKD (mean s.d)	8.8 (7.5)	8.7 (7.2)	9.8 (6.7)	10.1 (6.9)	9.4 (7.2)	9.6 (7.0)
All (n)	6690	537	20663	5113	2294	35297
Based on data from 35297 students at 89 secondary schools as part of the Year 2 COMPASS study						

Appendix H: Up to date school built environment data - exploratory analysis

When the school built environment characteristics are updated:

The descriptive statistics vary slightly. The Table 18 contains the updated values.

Table 18: Revised descriptive statistics for the 89 schools in the Year 2 (2013-2014) sample of the COMPASS study by school size

	School size (number of students enrolled)			
Variable	<500 (n=21) mean (sd)	500-1000 (n=52) mean (sd)	>1000 (n=16) mean (sd)	Total (n=89) mean (sd)
Number of indoor facilities	2.8 (1.9)	2.7 (1.3)	3.0 (0.7)	2.8 (1.4)
Number of outdoor facilities	3.8 (2.8)	2.9 (1.5)	4.1 (1.9)	3.3 (2.0)
Total number of facilities	6.5 (4.2)	5.6 (2.5)	7.1 (2.1)	6.1 (3.0)
Average condition of facilities [a]	2.4 (0.5)	2.7 (0.3)	2.6 (0.3)	2.6 (0.4)
Facility access during non-instructional time [b]	2.7 (0.7)	2.6 (0.6)	1.7 (1)	2.5 (0.8)
Accessibility score [c]	9.7 (2.0)	10.3 (1.8)	8.7 (3.1)	9.9 (2.2)

Based on data from 89 secondary schools
a= Facilities that were not rated were not included in the average
b= Access to indoor facilities, outdoor facilities and equipment were added together to give a maximum of 3 (only looks at 88 schools due to missing data). Missing data was counted as a "no" unless all were missing.
c= Average score when taking into account 13 criteria for accessibility. Missing data was taken as a "no" unless all were missing.

ICCs remain the same.

The univariate and multivariate models showed no differences in significance, except:

- Average condition of facilities changed by one decimal place, but with no change in significance.

The final models remain the same.